ARTICLE V.

SYNOPSIS OF THE VERTEBRATE FAUNA OF THE PUERCO SERIES.

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Read before the American Philosophical Society, January 20, 1888.

The Puerco formation rests on the Laramie in Northwestern New Mexico and Southwestern Colorado, and is largely covered by the Wasatch Eocene in both regions. It was discovered by the writer in 1874 at its eastern outcrop of about 500 feet thickness, and was identified by Endlich and Holmes in Colorado in 1876, where the thickness reaches 1000 to 1200 feet. On the San Juan river its thickness is 700 feet, while at its western outcrop south of that river, its thickness is 800 or 900 feet. While the formation possesses lithological peculiarities, no clue to its importance in geologic chronology was known until the discovery of vertebrate remains was made in 1880, by Mr. David Baldwin. With the evidence derived from this material, the writer has been able to interject into the series of epochs of geological time a period which must have possessed many peculiarities, and which differed in such important essentials from those which preceded and from those that followed it, that an immense interval between them is proven to have existed, such as had not been previously suspected. The rich fauna which it contains displays characters which indicate other discoveries yet to be made before connections with other epochs both prior and subsequent can be known.

The vertebrate fauna includes up to the present date one hundred and six known species. Four species of Mollusca have been discovered, which have been determined by Dr. C. A. White of the U. S. National Museum. They are *Unio rectoides* White; *Helix adipis* White; *H. nacimientensis* White, and *Pupa leidyi* Meek. The first named is found in the Wasatch, and the last in the ? Bridger; the two other species are peculiar. Besides these the only other indication of organic life at that period is petrified wood of undetermined trees, which is quite abundant.

The character of the vertebrate fauna is indicated by the following table:

Reptilia			12
Crocodilia		3	
Testudinata		5	
Rhynchocephalia		3	
Ophidia		1	
Aves			1
Mammalia			93
? Marsupialia		11	
Bunotheria		52	
Tæniodonta	3		
Creodonta	49		
Taxeopoda		28	
Quadrumana	?4		
Condylarthra	24		
Amblypoda		2	
Total			106

In 1874 the writer advanced the proposition that the ancestors of modern placental Mammalia would be found to be "plantigrade pentadactyle bunodonts." This anticipation was partly realized in the fauna of the Wasatch epoch subsequently discovered, but is completely so in the characters of the Mammalia of the Puerco epoch. All the placentals, and probably the implacentals also, were "plantigrade pentadactyle bunodonts." More than this the placentals nearly all present the primitive type of dentition of the maxillary series, since the superior molars are nearly all of the tritubercular type. But four species out of the eighty-two placentals are quadritubercular. In the inferior molars the tuberculo-sectorial, or quinquetubercular type of dentition, is extensively prevalent, but not so generally so as the superior tritubercular. Thus of the eighty-two placentals sixty-four present the primitive type.

In its relations to other faunæ, the Puerco is totally distinct as to species. No determined species came to it from an earlier epoch, and none continued after it. Of genera not widely distributed in time, one of lizard-like Rhynchocephalia, Champsosaurus, comes over from the Laramie, with a genus of tortoises, Compsemys. Another genus of tortoises, Chelydra, probably commences at this epoch, to continue through the European Miocenes to the present time, since it still exists in North America. Among Mammalia, two genera only continue later. Didymictis is found in the Wasatch and Bridger formations, and Chriacus in the Wasatch. Not only this, but the entire family of the Periptychidæ ceased at the close of the Puerco. The same is true of the Amblypod family Pantolambdidæ. One of the most important features of the fauna is, however, the presence of eleven species of the ? Marsu-

pialia Multituberculata, a suborder which commenced in the Triassic age, and which terminated its existence so far as the Northern hemisphere is concerned with the end of the Puerco epoch. This series of animals gives a Mesozoic character to the fauna, which is not necessarily counterbalanced by the characters of the remaining types. The placentals are in all probability those which existed during the latter part of Mesozoic time, and the absence of some of the forms of the Eocene increases the weight of the impression thus produced. Thus two orders universally present in the Eocenes, the Perissodactyla and the Rodentia, are wanting from the Puerco.

In conclusion it may be safely asserted that in the Puerco fauna we find the ancestors of the species of Eocene and of later times. In the Tæniodonta we get ancestors of Tillodonta and probably of Rodentia and Edentata. In Creodonta we get the ancestors of the Carnivora, in the family of the Miacidæ. In the Condylarthra we get the ancestors of the Diplarthra and Amblypoda, and in the Puerco Amblypoda the ancestors of those of the following epochs. Hence the investigation of this fauna possesses an especial interest for the mammalogist and for the evolutionist, as well as for the geologist proper.

I give first a list of the species, and then give descriptions of new species, with the osteology of such as the material permits.

In describing the dentition I have, after consultation with my friend Professor W. B. Scott, of Princeton, followed the method of enumeration of premolar teeth introduced by Kowalevsky, and adopted by Schlosser. In this method the premolar teeth are counted from behind forwards, so that the one usually enumerated as number four becomes number one, and *vice versa*.

The only catalogue of the Vertebrata of the Puerco which has appeared was published in the Proceedings of the American Philosophical Society for 1882, beginning at page 461. Since that time the following publications relating to that fauna have appeared:

First Addition to the Fauna of the Puerco Eocene. By E. D. Cope, loc. cit., 1883, Jan., p. 545.
Second Addition to the Knowledge of the Fauna of the Puerco Epoch, loc. cit., 1883, Dec., p. 309.
On Some Fossils of the Puerco Formation. Proc. Acad. Nat. Sci. Phila., 1883, p. 168.
The Tertiary Vertebrata of the West. Report U. S. Geol. Surv. Terrs., F. V. Hayden, Vol. III, Feb., 1885.
On Some New Tæniodonta of the Puerco. Amer. Naturalist, 1887, p. 469.
The Marsupial Genus Chirox, loc. cit., 1887, p. 566.

The present enumeration brings together all the species hitherto described, and adds a number of new ones. The whole number, it will be observed, reaches 106, which are referred to thirty-four genera.

Information at present available indicates that there is some faunal difference

between the lower and upper beds of the formation. I give a list of species which have been found in the lower part of the formation only, and leave for future research to determine whether they occur in the upper part of the formation or not:

MARSUPIALIA.	*Neoplagiaulax americanus.*
	Polymastodon taöensis.
	" *attenuatus.*
	" *latimolis.*
CREODONTA.	*Hemiganus otariidens.*
	Onychodectes tisonensis.
	Mioclænus pentacus.
	" *bathygnathus.*
	" *crassicuspis.*
	" *coryphæus.*
	" *gaudrianus.*
	" *filholianus.*
	" *turgidunculus.*
	Chriacus priscus.
	" *hyattianus.*
	" *ruetimeieranus*
	Triïsodon biculminatus.
CONDYLARTHRA.	*Periptychus brabensis.*
	" *coarctatus.*
	Ectoconus ditrigonus.

All but one of the species of Mioclænus belong to the section Sarcothraustes, which has five cusps on the inferior true molars.

REPTILIA.

CROCODILIA.

Crocodilus sp.
Crocodilus sp.
Crocodilus sp.

TESTUDINATA.

Plastomenus ? communis Cope.
Chelydra crassa Cope, sp. nov. infra.
Compsemys sp.
Emys sp.
Trionyx sp.

RHYNCHOCEPHALIA.

Champsosaurus australis Cope ; Amer. Naturalist, 1881, p. 690 ; Tertiary Vertebrata, p. 107, Pl. XXIII b, figs. 1–4.
Champsosaurus puercensis Cope ; Proc. Amer. Phil. Soc., 1881, p. 195 ; Tertiary Vertebrata, p. 107, Pl. XXIII b, figs. 5–10.
Champsosaurus saponensis Cope ; loc. cit., 1881, p. 196, p. 109, Pl. XXIII b, figs. 11–22.

OPHIDIA.

Helagras prisciformis Cope; Proc. Amer. Phil. Soc., 1883, p. 545; Tertiary Vertebrata, 1885, p. 731, Pl. XXIV g, fig. 2. Several individuals.

AVES.

Fragments of bones of a few undetermined species of birds have been found.

MAMMALIA.

? MARSUPIALIA.

It has been recently discovered that the genus Ornithorhynchus possesses, in an early stage, molar teeth exceedingly similar to those of the genus Ptilodus. I suspect for this reason, that the Multituberculata belong to the Monotremata rather than to the Marsupialia. This fact, if demonstrated, will account for the taxonomic isolation of this group from the known Marsupialia, though some Monotreme has probably given origin to the latter. (See Amer. Naturalist, Feb., 1888.)

Multituberculata.

Ptilodus mediævus Cope; Amer. Naturalist, 1881, p. 922; Tertiary Vertebrata, p. 173, Pl. XXIII d, fig. 1. Five individuals.

Ptilodus trovessartianus Cope; loc. cit., 1882, p. 686; Tertiary Vertebrata, p. 737, Pl. XXV f, fig. 19. Two individuals.

Additional and much more perfect specimens of the lower jaws of this species confirm its characters as originally defined.

Neoplagiaulax americanus Cope; Amer. Naturalist, 1885, p. 493. One individual.

Neoplagiaulax molestus Cope; loc. cit., 1886, p. 451, et infra. Two individuals.

Chirox plicatus Cope; Proc. Amer. Phil. Soc., 1883, p. 321; Amer. Naturalist, 1887, p. 566, fig. Two individuals.

Polymastodon latimolis Cope; Amer. Naturalist, 1885, p. 385. One individual.

Polymastodon taöensis Cope; loc. cit., 1882, p. 684; 1884, p. 688, figs. 3-4; Tertiary Vertebrata, p. 732, Pl. XXIII c, figs. 1-6. *Tæniolabis scalper*, Amer. Naturalist, 1882, July; Tertiary Vertebrata, p. 193, Pl. XXIII e, fig. 7. *Catopsalis pollux* Cope; Amer. Naturalist, 1882, p. 685; Tertiary Vertebrata, 1885, p. 734, Pl. XXIII c, figs. 1-5. Twenty individuals.

Polymastodon attenuatus Cope; Amer. Naturalist, 1885, p. 494. One individual.

Polymastodon fissidens Cope; Amer. Naturalist, 1884, p. 688. *Catopsalis fissidens* Cope; Proc. Amer. Phil. Soc., 1883, p. 322. One individual.

Polymastodon foliatus Cope; Amer. Naturalist, 1884, p. 688, fig. 5. *Catopsalis foliatus* Cope; loc. cit., 1882, p. 416; Tertiary Vertebrata, 1885, p. 171, Pl. XXIII d, fig. 2. One individual.

BUNOTHERIA.

Tæniodonta.

Psittacotherium aspasiæ Cope; Proc. Amer. Phil. Soc., 1882, p. 192; Tertiary Vertebrata, p. 196, Pl. XXIV c, figs. 3-4. Two individuals.

Psittacotherium multifragum Cope; Amer. Naturalist, 1882, p. 156; Proc. Amer. Phil. Soc., 1881, p. 191; Tertiary Vertebrata, p. 196, Pl. XXIV c, fig. 2; Amer. Naturalist, 1888, p. 5, fig. 1. Three individuals.

Psittacotherium megalodus Cope; Amer. Naturalist, 1887, p. 469. One specimen.

Creodonta.

Hemiganus vultuosus Cope ; Amer. Naturalist, 1882, p. 831 ; Tertiary Vertebrata, 1885, Pl. XXIII c. Four specimens.

Hemiganus otariïdens Cope ; Amer. Naturalist, 1885, p. 492 ; et infra. One specimen.

Conoryctes comma Cope ; Proc. Amer. Phil. Soc., 1881, p. 486 ; Tertiary Vertebrata, 1885, p. 198, Pl. XXIII e, figs. 1–5 ; XXV c, figs. 3–4. *Hexodon molestus* Cope ; Amer. Naturalist, 1884, p. 795, fig. 3. Seven individuals.

Onychodectes tisonensis Cope, gen. et sp. nov. infra. Three individuals.

Mioclænus antiquus Cope. *Sarcothraustes antiquus* Cope ; Proc. Amer. Phil. Soc., 1881(2), p. 193 ; Tertiary Vertebrata, 1885, p. 347, Pl. XXIV d, figs. 19–22. One specimen.

Mioclænus conidens Cope. *Triïsodon conidens* Cope ; Proc. Acad. Phila., 1882, p. 297 ; Tertiary Vertebrata, 1885, p. 274, Pl. XXIII d, figs. 9–10. *Diacodon conidens ;* Amer. Naturalist, 1884, p. 350. Three specimens.

Mioclænus bathygnathus Cope, sp. nov. infra. One specimen.

Mioclænus crassicuspis Cope. *Conoryctes crassicuspis* Cope ; Tertiary Vertebrata, p. 201, 1885, Pl. XXXIII e, fig. 6. Three specimens.

Mioclænus coryphæus Cope. *Sarcothraustes coryphæus* Cope ; Amer. Naturalist, 1885, p. 386. Nine specimens.

Mioclænus pentacus Cope, sp. nov. infra. Seven individuals, from the Lower Puerco.

Mioclænus gaudrianus Cope, sp. nov. infra. One specimen.

Mioclænus lydekkerianus Cope, sp. nov. infra. Three specimens.

Mioclænus filholianus Cope, sp. nov. infra. Four specimens.

Mioclænus interruptus Cope. *Deltatherium interruptum* Cope ; Proc. Amer. Phil. Soc., 1882, p. 463 ; Tertiary Vertebrata, 1885, p. 282, Pl. XXIII d, fig. 13. One specimen.

Mioclænus acolytus Cope. *Hyopsodus acolytus* Cope ; Proc. Amer. Phil. Soc., 1882, p. 462 ; Tertiary Vertebrata, 1885, p. 238, Pl. XXXIII d, figs. 5–6. Five specimens.

Mioclænus assurgens Cope. *Triïsodon assurgens ;* Proc. Amer. Phil. Soc., 1883, p. 311. Two specimens.

Mioclænus levisanus Cope. *Triïsodon levisanus* Cope ; Proc. Amer. Phil. Soc., 1883, p. 446 ; Tertiary Vertebrata 1885, p. 273, Pl. XXIV f, fig. 3. Six specimens.

Mioclænus heilprinianus Cope. *Triïsodon heilprinianus* Cope ; Proc. Amer. Phil. Soc., 1886, p. 193 ; Tertiary Vertebrata, 1885, p. 273, Pl. XXIII d, fig. 11. One specimen.

Mioclænus rusticus Cope. *Triïsodon rusticus* Cope ; Proc. Amer. Phil. Soc., 1882, p. 360. One specimen.

Mioclænus subtrigonus Cope ; Proc. Amer. Phil. Soc., 1881, p. 491 ; 1883, p. 555 ; Tertiary Vertebrata, 1885, p. 338, Pl. LVII f, fig. 5, LIV f, fig. 4. Seventeen specimens.

Mioclænus cuspidatus Cope ; Proc. Amer. Phil. Soc., 1883, p. 312. One specimen.

Mioclænus protogonioïdes Cope ; Amer. Naturalist, 1882, p. 833 ; Tertiary Vertebrata, 1885, p. 340, Pl. XXV f, fig. 17. Four specimens.

Mioclænus floverianus Cope, sp. nov. infra. One specimen.

Mioclænus corrugatus Cope, Proc. Amer. Phil. Soc., 1883, p. 560 ; Tertiary Vertebrata, 1885, p. 341, Pl. XXIV f, fig. 5 ; XXIV g, fig. 8 bc ("M. ferox"). Six specimens.

Mioclænus ferox Cope ; Proc. Amer. Phil. Soc., 1883, p. 547 ; Tertiary Vertebrata, 1885, p. 328, Pl. XXIV f, fig. 6 et seq. Four specimens.

Mioclænus opisthacus Cope ; Amer. Naturalist, 1882, p. 833 ; Proc. Amer. Phil. Soc., 1883, p. 312. *Hemithlæus opisthacus* Cope ; Tertiary Vertebrata, 1885, p. 407, Pl. XXV f, figs. 8–9. Twelve specimens.

Mioclænus turgidus Cope ; Amer. Naturalist, 1881, p. 489 ; loc. cit., 1881, p. 830 ; Tertiary Vertebrata, 1885, p. 325, Pl. LVII f, fig. 3–4 ; XXV e, figs. 19–20. Twenty-five specimens.

Mioclænus zittelianus Cope, sp. nov. infra. One specimen.

Mioclænus turgidunculus Cope, sp. nov. infra. Three specimens.

Mioclænus minimus Cope, Proc. Amer. Phil. Soc., 1882, 468 ; Tertiary Vertebrata, 1885, p. 327, Pl. XXV e, figs. 22–4. Five specimens.

Tricentes bucculentus Cope ; Proc. Amer. Phil. Soc., 1883, p. 316. *Mioclænus bucculentus* Cope ; Proc. Amer. Phil. Soc., 1883, p. 555 ; Tertiary Vertebrata, 1885, p. 341, Pl. XXIV g, fig. 2. Three specimens.

Tricentes crassicollidens Cope; Proc. Amer. Phil. Soc., 1883, p. 315. One specimen.

Tricentes inæquidens Cope; loc. cit., 1883, p. 317. Two specimens.

Chriacus truncatus Cope; Proc. Amer. Phil. Soc., 1883, p. 313. Six specimens.

Chriacus pelvidens Cope; Proc. Amer. Phil. Soc., 1883, p. 314; Tertiary Vertebrata, 1885, p. 740. *Lipodectes pelvidens* Cope; Amer. Naturalist, 1881, p. 1019. *Pelycodus pelvidens* Cope; Tertiary Vertebrata, 1885, p. 225, Pl. XXIII d, figs. 7–8. Six specimens.

Chriacus simplex Cope; Proc. Amer. Philos. Soc., 1883, p. 314. One specimen.

Chriacus priscus Cope, sp. nov. infra. Six specimens; Lower Puerco.

Chriacus schlosserianus Cope, sp. nov. infra. Four specimens; Upper Puerco.

Chriacus baldwini Cope. *Deltatherium baldwini;* Proc. Amer. Phil. Soc., 1882, p. 463; Tertiary Vertebrata, 1885, p. 282, Pl. XXIII d, fig. 12. Three specimens.

Chriacus hyattianus Cope; Amer. Naturalist, 1885, p. 385. *Loxolophus adapinus* Cope; loc. cit., p. 386. Four specimens; Lower Puerco.

Chriacus ruetimeyeranus Cope, sp. nov. infra. One specimen.

Chriacus stenops Cope, sp. nov. infra. Three specimens; Upper Puerco.

Chriacus inversus Cope, sp. nov. infra. One specimen.

Deltatherium fundaminis Cope; Amer. Naturalist, 1880, p. 338; Tertiary Vertebrata, 1885, p. 278, Pl. XXIII e, figs. 8–11; XXV a, fig. 10; XXV d, fig. 3. *Lipodectes penetrans* Cope; Amer. Naturalist, 1881, p. 1019. Twenty-three specimens.

Triïsodon biculminatus Cope, sp. nov. infra. Two specimens; Lower Puerco.

Triïsodon quivirensis Cope; Amer. Naturalist, 1881, p. 667; Tertiary Vertebrata, 1885, p. 270; Pl. XXV c, fig. 2. One specimen.

Dissacus navajovius Cope; Amer. Naturalist, 1881, p. 1019; Tertiary Vertebrata, West, 1885, p. 344, 741. Eight individuals.

Dissacus carnifex Cope; Amer. Naturalist, 1882, p. 834; Tertiary Vertebrata, 1885, p. 345, Pl. XXIV g, figs. 3–4. One individual.

Didymictis haydenianus Cope; Proc. Amer. Phil. Soc., 1882, p. 464; Tertiary Vertebrata, 1885, p. 306; Pl. XXIII e, figs. 12–13. Three specimens.

Didymictis primus Cope; Proc. Amer. Phil. Soc., 1883, p. 309. Three specimens.

? Lemuroidea.

Mixodectes pungens Cope; Proc. Amer. Phil. Soc., 1883, p. 447; Tertiary Vertebrata, 1885, p. 241, Pl. XXIV f, fig. 1. Two specimens.

Mixodectes crassiusculus Cope; Proc. Amer. Phil. Soc., 1883, p. 447; Tertiary Vertebrata, 1885, p. 242, Pl. XXIV f, fig. 2. Three individuals.

Indrodon malaris Cope; Proc. Amer. Phil. Soc., 1883, p. 318. One specimen.

CONDYLARTHRA.

Haploconus corniculatus Cope, sp. nov. infra. Six specimens.

Haploconus lineatus Cope; Amer. Naturalist, 1882, p. 417; Tertiary Vertebrata, 1885, p. 417, Pl. XXV e, fig. 1–4. Twenty-four specimens.

Haploconus angustus Cope; Tertiary Vertebrata, 1885, p. 416, Pl. LVII f, fig. 6. *Mioclænus angustus* Cope; Amer. Naturalist, 1881, p. 831. Two specimens.

Haploconus xiphodon Cope; Proc. Amer. Phil. Soc., 1882, p. 466; Tertiary Vertebrata, 1885, p. 420, Pl. XXV e, figs. 5–6. Two specimens.

Haploconus entoconus Cope; Amer. Naturalist, 1882, p. 686; Tertiary Vertebrata, 1885, p. 421, Pl. XXV f, figs. 4–5.

Haploconus cophater Cope. *Anisonchus cophater;* Proc. Amer. Phil. Soc., 1882, p. 321. Three specimens.

Anisonchus mandibularis Cope. *Mioclænus mandibularis* Cope; Amer. Naturalist, 1881, p. 831; Tertiary Vertebrata, 1885, p. 339, Pl. LVII f, fig. 7. Two specimens.

Anisonchus sectorius Cope; Proc. Amer. Phil. Soc., 1881, p. 488; Tertiary Vertebrata, 1885, p. 413, Pl. XXV c, figs. 5–6 and 8. *Mioclænus sectorius* Cope; Amer. Naturalist, 1881, p. 831. Thirteen individuals.

Anisonchus coniferus Cope; Amer. Naturalist, 1882, p. 833; 1884, p. 803, fig. 12 c; Tertiary Vertebrata, 1885, p. 409. Four specimens.

Anisonchus gillianus Cope; Proc. Amer. Phil. Soc., 1882, p. 467; Tertiary Vertebrata, 1885, p. 411, Pl. XXV f, figs. 10–11. *Haploconus gillianus* Cope; Amer. Naturalist, 1882, p. 686. Eight individuals.

Anisonchus agapetillus Cope; Proc. Amer. Phil. Soc., 1883, p. 320. Six specimens.

Zetodon gracilis Cope; Tertiary Vertebrata, Pl. XXIX d, explanation, and fig. 9. Two individuals.

Hemithlæus apiculatus Cope. *Anisonchus apiculatus* Cope; Tertiary Vertebrata, Pl. XXV e, fig. 7. Eight individuals.

Hemithlæus kowalevskianus Cope; Amer. Naturalist, 1882, p. 833; Tertiary Vertebrata, 1885, p. 405, Pl. XXV f, figs. 6–7. Sixteen specimens.

Periptychus brabensis Cope, sp. nov. infra. Fourteen individuals; the Lower Puerco.

Periptychus coarctatus Cope; Tertiary Vertebrata, Pl. XXIX d, explanation and figs. 7–8. Five individuals; from the Lower Puerco.

Periptychus carinidens Cope; Amer. Naturalist, 1881, p. 337; Proc. Amer. Phil. Soc., 1881, p. 484; Tertiary Vertebrata, 1885, p. 403, Pl. XXV a, fig. 16; XXIII d, figs. 14–15; XXIV g, fig. 5. Five specimens.

Periptychus rhabdodon Cope; Tertiary Vertebrata, 1885, p. 391, Pl. XXIII f, XXIII g, figs. 1-11; LVII, figs. 1–2; Amer. Naturalist, 1884, p. 801, figs. 1–2 and 6–9. *Catathlæus rhabdodon* Cope; Amer. Naturalist, 1881, p. 830; Proc. Amer. Phil. Soc., 1881, p. 487. One hundred and thirty-eight individuals; from the Upper Puerco.

Ectoconus ditrigonus Cope; Amer. Naturalist, 1884, p. 796, figs. 4–5. *Periptychus ditrigonus* Cope; Tertiary Vertebrata, 1885, p. 404, Pl. XXIII g, fig. 12; XXIX d, figs. 2–6. Thirty-two individuals; from the Lower Puerco.

Protogonia zuniensis Cope. *Phenacodus zuniensis* Cope; Proc. Amer. Phil. Soc., 1881, p. 492; Tertiary Vertebrata, 1885, 491, Pl. LVII f, fig. 10. Three individuals.

Protogonia calceolata Cope. *Phenacodus calceolatus;* Proc. Amer. Phil. Soc., 1883, p. 559; Tertiary Vertebrata, 1885, p. 487. One individual.

Protogonia plicifera Cope; Amer. Naturalist, 1882, p. 833; Tertiary Vertebrata, 1885, p. 424, Pl. XXV f, figs. 2–3. Eight individuals.

Protogonia puercensis Cope. *Phenacodus puercensis* Cope; Proc. Amer. Phil. Soc., 1881, p. 492; Tertiary Vertebrata, 1885, p. 488, Pl. XXV e, figs. 12–13; LVII f, figs. 8–9. *Protogonia subquadrata* Cope; Proc. Amer. Phil. Soc. 1881, p. 492; Tertiary Vertebrata, 1885, p. 426, Pl. LVII f, figs. 11–12. Twenty-five individuals.

AMBLYPODA.

Pantolambda bathmodon Cope; Amer. Naturalist, 1882, p. 418; Proc. Amer. Phil. Soc., 1883, p. 558; Tertiary Vertebrata, 1885, p. 601, Pl. XXIX b, XXIX c. Seven individuals.

Pantolambda cavirictus Cope; Tertiary Mammalia, Pl. XXIX d, explanation and fig. 1. Four individuals.

DESCRIPTIONS OF SPECIES.

TESTUDINATA.

CHELYDRA Schw.

Char. gen.—Marginal bones of the bridge united with the costals by simple gomphosis, and with the plastron by compound gomphosis. Bridge of plastron nar-

row, with an intermarginal series of scuta, and without fontanelle. Surfaces not sculptured.

CHELYDRA CRASSA sp. nov. *Dermatemys sp.* Cope; Proc. Amer. Phil. Soc., 1882, p. 461.

This species is represented in my collection by fragments of two individuals. Of the typical specimen there are preserved, two vertebral, nine marginal, and three plastral bones; of the second, three vertebral bones. The specimens indicate an animal of the average size of the existing snapping turtle, *Chelydra serpentina.*

The bones of both carapace and plastron are relatively much thicker than the corresponding parts of the snapping tortoise, equaling in this respect the largest existing species of Emys. The bridge of the plastron is not so slender as in *C. serpentina.* The vertebral bones have a median keel-like angle, which becomes at the anterior part of each vertebral scutum a prominent rib. This results from the abrupt depression of the surface on each side immediately posterior to the transverse dermal suture. In the larger specimen this suture is deeply notched anteriorly, and its anterior border is so prominent posteriorly as to give an imbricate appearance, the anterior vertebral scute rolling over the posterior by an obtuse border. The marginals of the bridge are very massive, and the pit for the process of the costal is at one side of the middle, and is nearly round. It is flat in the *C. serpentina.* The pits for the plastral fingers are three, on the inner inferior edge of each marginal, and are directed obliquely. The external face of the marginals is distinguished by a rabbet, the inferior margin of which projects as a ridge beyond the external face. Inferior face convex. No other except the fine mutual sutures on the marginals of the bridge. The free marginals, of which I have two, and one of them the anal, have no gomphosis nor suture with the costals or pygal, being held in place by the integuments and by the mutual marginal sutures. The dermal scuta are well marked, the marginals having their bounding suture below that of the marginal bones. Surface of the shell everywhere smooth.

Measurements.

No. 1.			*Inch.*
Anteroposterior diameter of vertebral bone			.8
Diameters of marginal of bridge	anteroposterior		.83
	transverse (greatest)		.35
	vertical		.98
Diameters of anal marginal	anteroposterior		.13
	vertical		.35
	transverse		.43
Diameters of hyosternal	anteroposterior	interiorly	1.00
		medially	.43
	transverse (without gomphosis)		1.90
	vertical (at middle)		.23

Measurements.

	No. 2.	*Inch.*
Diameters of vertebral bone	anteroposterior	1.13
	transverse	1.20
	vertical	.40

This is the oldest species which can be referred to this genus.

? MARSUPIALIA.

All of the Puerco implacentals belong to the suborder Multituberculata, and to three families, which are defined as follows:*

Premolars present, compressed and trenchant in form ..... *Plagiaulacidæ.*
Premolars present, molariform, different from true molars in form ..... *Chirogidæ.*
Premolars wanting or rudimental ..... *Polymastodontidæ.*

To the first belong, in the Puerco fauna, Ptilodus and Neoplagiaulax; to the second, Chirox; and to the third, Polymastodon.

NEOPLAGIAULAX Lemoine.

Bulletin of the Geological Society of France, 1881, November.

I have referred the American species of Plagiaulacidæ with but one, the first inferior premolar, to the above genus. Those with two premolars I have referred to Ptilodus (October, 1881).

NEOPLAGIAULAX MOLESTUS Cope; Amer. Naturalist, 1886, p. 451.

This species was established on a separate first inferior premolar. I now describe a mandibular ramus which probably belongs to it. It has suffered the loss of the crown of the molar, and the greater part of that of the premolar teeth. The latter has its base oblique in both the vertical and horizontal directions; its posterior base rounded. True molars small, and on the inner side of the coronoid process. Incisor one, rodent-like. Angular inflection of the mandible well developed, but the posterior border has been broken away. Its form is robust, especially at the external base of the large premolar tooth, where a longitudinal swelling rises posteriorly, and disappears in the base of the coronoid process. Below and posterior to this protuberance the masseter fossa extends, having an oblique boundary below in the externo-superior face of the external inflection of the base of the ramus. The internal inflection commences more posteriorly, and projects inwards at a right angle to the vertical plane. Anterior to these inflections the inferior outline of the ramus is gently convex downwards in conformity to the arc required by the alveolus of the large

* Amer. Naturalist, 1884, p. 687; 1887, p. 567.

inferior incisor. The latter issues from the jaw at a considerable distance in advance of the first premolar, leaving a wide diastema, which has a rather wide and obtuse superior surface. The alveoli of the true molar are within the base of the coronoid process, and indicate a tooth of much smaller size than the premolar. The symphysis is short, and is indicated almost exclusively by rugosities of the inferior and anterior border of the extremity of the ramus. The articulation has been a loose one by ligament.

Measurements.	*M.*
Length of fragment of ramus	.057
" " diastema	.013
Diameters p. m. i anteroposterior	.013
Diameters p. m. i transverse posteriorly	.005
Length of base of m. i (estimated)	.006
Depth ramus at diastema	.016
" " " posterior base of p. m. i	.021
Diameters of incisor vertical	.007
Diameters of incisor transverse	.004

The tooth from which the species was originally characterized has the following characters: Length of base one-third greater than in *Neoplagiaulax americanus*, and there are fifteen keel-crests on the side of the crown, while there are but seven in the *N. americanus*. The outline of the crown is elongate and moderately convex, and less elevated than in the known species of Ptilodus. The irregularity in the outline of the base of the crown is less than in the other species, and the diameter of the roots is subequal. The anterior base of the crown is not excavated for the second premolar as in Ptilodus. Length of base of crown, 16 mm.; elevation at middle, 8 mm.

In size this species is about equal to the *Polymastodon foliatus*.

CREODONTA.

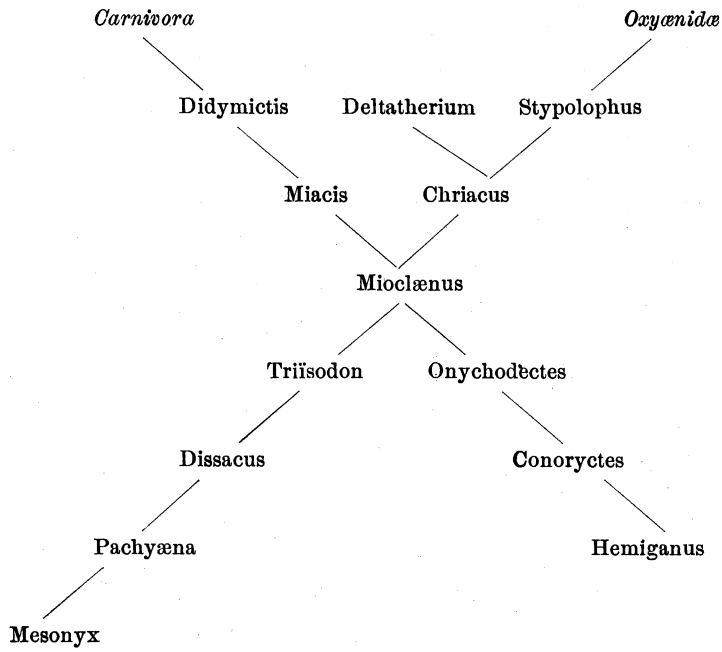
Important additions to the knowledge of this suborder have been made recently by Professor W. B. Scott* and Dr. Max Schlosser.† The former has determined the presence of the subcylindric postzygapophyses in Didymictis, and I have ascertained their existence in Esthonyx and Dissacus. Scott shows that in Hyænodon the characters of the carpus and of the brain coincide with those of this group. He also finds an os centrale in that genus and in Mesonyx, and Osborn has found it in Esthonyx.

In the following pages considerable additions to the general osteology of Hemi-

* On Some New and Little-known Creodonta; Jour. Acad. Phil., 1886, p. 155.

† Die Affen, Lemuren, Chiropteren, Insectivoren, Marsupialia, Creodonten und Carnivoren des Europäischen Tertiärs; Wien, 1887. Alfred Hölder.

ganus, Onychodectes, Mioclænus, Chriacus and Dissacus are made, and they throw considerable light on the phylogeny of the various genera. It is apparent on all grounds that Mioclænus is the central type of Creodonta for the Puerco Epoch, and that all other types of the suborder may be traced to it as derivative, either by progressive or retrogressive specialization. Thus the line which our present knowledge ends with Hemiganus, is one of simplification and reduction of the molar dentition at the expense of increase in the development of the canine dentition, as takes place in the line of the seals. In the line of the Mesonychidæ another kind of simplification of the molar dentition of the inferior series appears, and the feet undergo specialization, apparently in accordance with the needs of a terrestrial life. A third line leading towards the Oxyænidæ commences with the genus Chriacus, which is easily modified into Stypolophus on the one hand and Deltatherium on the other, the latter having some special characters of its own, and forming probably the end of its line. The line which gives us Miacidæ, and in Miocene times the Carnivora, probably diverged from a Mioclænus, but from a species of an earlier horizon than the Puerco, since two species of Didymictis are already contemporaries with the Mioclænus of that age. These relations may be displayed as follows :



In the reference of these genera to families, lack of information as to certain parts of the structure forbids final conclusions. Leaving aside the Miacidæ and Oxyænidæ, we find that the Proviverridæ (Schlosser, Leptictidæ, Div. II, Cope) em-

braces Deltatherium, Mioclænus, and probably Triïsodon and Onychodectes, of the Puerco genera. Dissacus is on the boundaries of the Mesonychidæ, but the ungues are unknown, and the astragalus is not trochlear. That Hemiganus can be referred to the Proviverridæ is improbable. The characters of a family Hemiganidæ would be: *Superior molars with confluent roots, and tritubercular crowns; inferior molars quadritubercular; astragalus not trochlear; ungues much compressed.* The sole character separating this family from the Proviverridæ is the confluence of the roots of the superior true molars. It is approached in this respect by the genus Conoryctes, which will, however, remain in the Proviverridæ as an aberrant form, connected with Mioclænus by Onychodectes. The tendency of this group is to resemble the Tæniodonta, but whether there is any affinity involved in this resemblance does not yet appear.

The line of the Mesonychidæ shows definite changes in the following respects: First, loss of the internal cusps of the inferior molars. The diminution of these cusps is seen most prominently at first in the genus Triïsodon, and more distinctly in the later *T. quivirensis* than in the earlier *T. biculminatus*. It has progressed far in Dissacus. Second, in the reduction of the number of the digits; the hallux has become very small in Dissacus and is gone in Mesonyx. Third, in the production of a distinct facet for the cuboid bone on the extremity of the astragalus. The contact of the astragalus and cuboid is seen in many if not all Creodonta, but the navicular and cuboid surfaces are not distinguished from each other. In Mesonyx and Pachyæna it is well known that they form distinct facets separated by an angle, as in Perissodactyla. This structure appears in a primitive condition in Dissacus, the angle being obtuse and rounded. It is an excellent illustration of the origin of a zoölogical character. The thoroughly diplarthrous type of the astragalus in Mesonyx is associated with an ungulate form of ungual phalanges, and I suspect that the resemblance is not accidental. The form of the distal end of the diplarthrous astragalus is probably due to impacts combined with energetic flexion and extension. But why the structure should appear in Mesonyx and not in Phenacodus is, as yet, an unanswered question.

Although it is now evident that the Pinniped Carnivora cannot be derived from the genus Mesonyx, as is truly maintained by Scott, it appears to me that they have been derived, like other Carnivora, from some form of Creodonta. The retrograde development of the molar teeth probably passed through stages like those of Dissacus and Hemiganus, and the ungual phalanges might have been easily derived from such as are possessed by Pachyæna.

HEMIGANUS Cope.

Amer. Naturalist, 1882, p. 831; Tertiary Vertebrata, 1885, Pl. XXIII c, figs. 7–12; Amer. Naturalist, 1885, p. 492.

The claws are large and compressed like those of a prehensile-footed carnivore. The astragalo-tibial articulation is nearly flat. The femur is very robust, and has a low third trochanter, as in Bunotheria generally. The vertebræ of the neck are short and wide. The jaws have a very large and wide coronoid process, as in Calamodon, and the horizontal rami are very robust. Only one true molar (the first) is preserved, and it has the crown worn. Its outline is subround, with a notch on the internal side. There are probably but two true molars; they have two roots. There are at least four premolariform teeth, and their crowns are short, obtuse cones, with a low heel-like expansion at the inner side of the posterior base, and have but a single root. They resemble very nearly the teeth of some of the eared seals. There is a robust canine tooth in the upper jaw, which is not separated from the premolars by a diastema. There is at least one superior incisor, but the exact number is unknown. There is a large tooth on each side of the symphysis of the lower jaw, but in the specimens it is not in place. It has enamel on the anterior face only, and its apex is worn transversely. The wear descending passes to one side of the middle line. It evidently has a median position, and may be therefore an incisor. Its form reminds one of that of the second inferior incisor of Calamodon, but the enamel-face is much shorter.

Should the large inferior teeth be canines, the mandibular dentition will greatly resemble that of the seals, as does that of the maxillary bone. The absence of post-orbital angles resembles the condition in the Phocidæ. The wide vertical coronoid process and the flat vertical angle are as in Calamodon. The sagittal crest is elevated, and the brain-case very small.

This genus resembles in several respects the Tæniodonta, and confirms the propriety of the union of that group with the Creodonta into the order Bunotheria.

The typical species, *H. vultuosus*, was an animal of probably the size of a grizzly bear. A second and considerably smaller species is described below.

HEMIGANUS OTARIÏDENS Cope; Amer. Naturalist, 1885, p. 492. Hujus operis, Plates IV and V.

Only one individual of this species has been found, but it is represented by many parts of the skeleton. It was a plantigrade beast of about the size of a black bear, of robust proportions, and with a wide head with an exceedingly short thick muzzle, armed with some formidable teeth in front. These, with its sharp claws, made it the most formidable animal yet known of the Puerco fauna, excepting its larger and more powerful congener, the *H. vultuosus*.

The nares are well roofed by the nasal bones, which border the premaxillaries

above to the line of the front of the second superior incisor, by a wide sutural surface. The superior process of the premaxillary bone is short, not extending posterior to the vertical line of the posterior face of the superior canine tooth. A small foramen, perhaps the infraorbital, issues above the second tooth posterior to the canine. Exterior to the third tooth that follows the canine, the external face of the maxillary bone spreads outwards as though forming the malar process, and that this is the case is rendered probable by its smooth superior surface, which is the inferior orbital border. Just anterior to the orbital border, a large foramen from the maxillary antrum perforates the maxillary bone. The two teeth in the maxillary bone are injured, but the anterior has a conical crown and a single root, while the crown and base of the second are widened a little transversely. I can find no superior true molars in the collection.

The mandibular rami are remarkable for the shortness of the dentary portion, and the elevation and width of the coronoid process. The condyle is elevated above the alveolar border of the lower jaw, when the inferior border of the ramus is horizontal. The ramus increases in depth anteriorly, as in Tæniodonta, to accommodate the large anterior teeth. The inferior border is straight and compressed, and the posterior border is gently concave to a short rectangular angle, which does not extend posteriorly to the line of the base of the condyle. It is therefore much less prominent than in Creodonta generally, resembling in this respect the Tæniodonta. There are four alveoli for single-rooted molars, and apparently another one in front of the anterior one of the four. This would give seven molars, the first true molar having the form of a premolar; but the distribution of the teeth is not quite certain. As already described, the heel of these premolariform teeth is partly internal. The first true molar may be one of these simple teeth. The second has two roots, and the crown is about as wide as long. The crown consists of an anterior portion, which is slightly elevated above a posterior heel. The superior face of the crown is worn by mastication so that its construction is not evident, but there is no trace of a division between fourth and fifth tubercles, so that I suspect that the latter did not exist. It is not probable that there were well-marked cusps on the heel.

The parietal region of the skull is very much compressed, and the sides slope regularly upwards to the elevated sagittal crest. The temporal ridge is an oblique angular line of the surface, and the frontal region is flat. No other parts of the skull are preserved.

Measurements of Skull.	*M.*
Depth of maxillary bone at p. m. iv	.038
" " nasal " " canine	.031
Length of maxillary bone to orbital border	.045

Measurements of Skull.	M.
Diameters of canine { anteroposterior (oblique)	.015
Diameters of canine { transverse (oblique)	.012
Lengths of p. m. iii and iv	.016
" " seven inferior molars	.052
Diameters ? first true molar { anteroposterior	.085
Diameters ? first true molar { transverse	.072
Diameters ? first true molar { vertical	.050
Length of ramus posterior to molars { to condyle	.070
Length of ramus posterior to molars { to angle	.056
Diameters of coronoid { anteroposterior	.054
Diameters of coronoid { vertical	.044
Width of condyle	.017
Depth of ramus at coronoid	.081
" " " " m. iii	.034
" " " " p. m. iv	.042
Vertical depth of sagittal suture	.027

Only cervical vertebræ are preserved. These have small anteroposterior diameter, and their transverse exceeds their vertical diameter. In general they resemble those of Periptychus. The atlas is peculiar in the small anteroposterior diameter of the paradiapapohysis, whose base is perforated by an anteroposterior canal. It sends upwards a vertical keel to opposite the middle of the facet for the axis. The axis has a cylindric and rather slender odontoid process whose superior extremity is obliquely beveled on a curve. Its articular surface is continuous with the large atlantal facets laterally and inferiorly. The longitudinal axis of the cervical centra is oblique to the horizontal, showing that the head was elevated above the body. The floor of the neural canal is pierced by a foramen of considerable size on each side. A posterior (? seventh) cervical has a greater anteroposterior diameter than the two which precede it, and the vertical diameter is relatively greater. The posterior articular face of all three is slightly concave.

Measurements of Vertebræ.	M.
Anteroposterior diameter of atlas	.020
Width of axis at atlantal facets	.038
Length of odontoid process	.011
Diameters of centrum cervical ? iii { anteroposterior	.0085
Diameters of centrum cervical ? iii { vertical	.016
Diameters of centrum cervical ? iii { transverse	.026
Diameters of centrum cervical ? v { anteroposterior	.011
Diameters of centrum cervical ? v { vertical	.015
Diameters of centrum cervical ? v { transverse	.029
Diameters of centrum cervical ? vii { anteroposterior	.015
Diameters of centrum cervical ? vii { vertical	.016
Diameters of centrum cervical ? vii { transverse	.028

The anterior limb is represented by parts of both ulnæ, part of one radius, and a metacarpal of the pollex. More than half of one ulna is preserved. The olecranon appears to be short and terminating in an acute apex at the basal border; but it may have been broken off. The humeral cotylus is oblique, extending backwards and outwards, and inwards and forwards. The posterior border is elevated into a ridge, which is convex forwards. The anterior marginal ridge is limited to the external part, and it extends outwards, downwards, and then backwards, overhanging the internal face of the ulna. The radial facet is flat, and slopes gently, and not steeply inwards, it is bordered on the outer side by a low ridge, external to which is a longitudinal groove. Both do not extend far distad, and the superior edge of the shaft of the ulna is narrow and convex. The inferior edge is similar except below the humeral cotylus, where it is transversely flattened, the inferior face turning upwards on the inner side posteriorly. The internal side of the shaft of the ulna is concave, and the external side is convex. The head of the radius is a transverse oval, with subequal broadly rounded extremities. The superior border is openly shallowly excavated, while the inferior is obliquely beveled for the ulnar face. A short tuberosity projects longitudinally from the middle of the ulnar facet. A metacarpal, supposed to be that of the pollex, is quite short and robust and has a proximal excavation of the internal side for the trapezium. This concave facet extends half its length. The distal end is a subround convex facet which presents outwards. It has neither median keel nor groove. It indicates a robust digit.

Measurements of Anterior Limb.		*M.*
Length of fragment of ulna		.117
Depth at middle of glenoid surface		.026
Width " " " " "		.027
Depth at coronoid		.032
Depth at middle of shaft		.023
Diameters head of radius	vertical	.017
	transverse	.026
Diameters shaft radius .045 from proximal end	vertical	.012
	transverse	.012
Length of metacarpal of pollex		.020
Diameters distal facet of do.	vertical	.0135
	transverse	.0135

The femur lacks the distal extremity so that it is not possible to determine its exact length. Its proximal portion is robust, and about as large as that of a fully grown pig. That the animal is not fully grown is shown by the fact that the epiphysis of the head is not united, although it is preserved. The projection of the great trochanter is about equal to that of the head, and is robust, and truncate both

proximally and externally, and incloses a considerable trochanteric fossa. The head has a large fossa for the round ligament which is near the neck, from which it is separated by a low border. The little trochanter is quite prominent, and is reverted, but it is not connected with the great trochanter by a ridge. The third trochanter is well developed, and has a wide external surface, whose anterior edge is recurved forwards. Its upper portion overlaps the line of the inferior edge of the little trochanter, being higher up than in Pachyæna. The middle of the shaft is somewhat depressed, and its margins are rounded.

The proximal part of the left tibia, and the distal part of the right, give the characters of that element. The proximal part is laterally crushed. It is evident, however, that the crest is large and obtuse at the apex, and that the spines are low ridges. The externo-posterior border forms a roughened ridge for 35 mm. below the internal femoral surface, and ceases rather abruptly below. At or near the middle the shaft is normally somewhat compressed, and slender. The malleolus is very prominent, and terminates in an apex in its internal plane. The astragalar surface is but little oblique; the fibular articular surface is large.

One of the metatarsals shows that the foot was short, since it is neither the first nor the fifth. Its proximal face is concave in the transverse direction, but nearly straight anteroposteriorly. The arc of the phalangeal face is less than half a circle, and is slightly concave in transverse section. It is divided medially at its inferior fourth by a short, narrow, and low trochlear keel. Inferior border of phalangeal face prominent and openly emarginate. An ungual phalange is preserved, but whether of the anterior or posterior foot I do not know. Its apex is lost. It is strongly compressed, and has a narrowly rounded superior border. The phalangeal cotylus is deeply excavated, and is rather narrow, and has a weak median keel. The superior process overhangs the phalangeal surface rather further than the inferior. The tuberosity for the flexor tendon is a longitudinal oval, with surface transversely convex, which gradually ascends to the narrow but flat inferior surface of what remains of the phalange. The large nutritive foramen enters above its middle.

Measurements of Posterior Limb.		*M.*
Length of femur preserved		.123
Width at head		.061
Length proximad of little trochanter, inclusive		.064
" " " third " "		.085
Diameters shaft of femur	anteroposterior	.019
	transverse	.029
Diameters shaft of tibia	anteroposterior	.023
	transverse	.016

Measurements of Posterior Limb.		*M.*
Diameters distal end of tibia	anteroposterior	.025
	transverse	.030
Length of phalange		.024
Diameters of distal end	anteroposterior	.013
	transverse	.011
Depth of unguis	at tendinous insertion	.019
	anterior to tendinous insertion	.013
Width of unguis	at phalangeal surface	.009
	at tendinous tuberosity	.006
	anterior to tendinous tuberosity	.005

CONORYCTES Cope.

Proc. Amer. Phil. Soc., 1881, p. 486; Tertiary Vertebrata, 1885, p. 198. *Hexodon* Cope; Amer. Naturalist, 1884, p. 794.

Additional material representing the type species of this genus enables me to give the characters more fully than hitherto. The *C. comma* experienced an early obliteration of the details of the structure of the crowns of the molar teeth through the thinness of the enamel layer and the mastication of hard substances, so that they are seen in but few specimens.

The superior true molars, and the first premolar, have two external conical cusps, and an internal triangular table, whose inner angle is produced downwards to a line with the apices of the internal cusps. The inferior premolars and the first premolar have the anterior part much elevated above the posterior. The former consists of a large external and a small internal cusp joined to near their summits, except on the first premolar which has but one anterior cusp, which is simple acute cone. A rudimental fifth cusp is present on the true molars.

The mastication in this genus is affected by a scooping action of the keels of the inferior molars against the internal table of the superior molars by a motion which is partly transverse, as in Onychodectes.

There are probably four inferior premolars in this genus, but the anterior two have but one root each, and are close together. My supposition that some specimens had but three premolars led me to propose the genus Hexodon, which is now abandoned.

The position of the genus is doubtful, owing to the absence of the ungual phalanges. It is probably Creodont rather than Condylarthrous, for two reasons; one is the close resemblance of the dentition to those of Onychodectes and Hemiganus, between which it takes a natural position. The other is, that it displays no resemblance to any of the Condylarthra in the details of its structure.

But one species is known to me.

CONORYCTES COMMA Cope ; loc. cit., *Hexodon molestus* Cope ; loc. cit., fig. 3.

This animal was about the size of a wolverine, of which species one is reminded by its robust characters. It had an elevated sagittal crest and a strong inion. In a series of teeth which are but little worn the following characters may be discerned. The crown of the inferior canine has a flat inner face, beyond which the anterior surface extends inwards, forming a rib-like border. The enamel on the internal and posterior faces extends but a short way from the apex, and is thin, while on the convex anteroexternal face, it extends below the usual position. It thus approaches the condition seen in Hemiganus. A similar state of affairs is seen in the molars, where the enamel is extended much further on the external face of the inferior and the internal face of the superior molars than is usual, approaching the genera mentioned and also the Tæniodonta in this respect. There are no cingula on any of the molars of either series excepting on the external side of the superiors ; and there it sends out a process or cusp between the two external cusps. The crowns of the inferior molars are notched at the junction of the anterior and posterior parts. The notch is the section of a vertical groove from the base of the crown on the external side, and of a very short superficial one of the internal side. The fifth cusp is median, and about opposite the rim of the heel in elevation. The grooves of the first premolar are similar to those of the true molars. There is no anterior basal cusp. The heel is large and has a raised border on the posterior and inner sides, and an external median lateral conic cusp. This when worn joins the curved crest, forming a comma-shaped figure.

A specimen represented by fragments includes a canine characteristic of the genus, but of such relatively smaller size, that I suppose the animal to be a female.

Seven individuals have come under my observation.

ONYCHODECTES Cope, gen. nov.

Superior molars tritubercular, the external cusps distinct ; the internal with the intermediate confounded in a prismatic form with flat grinding surface, and whose internal angle rises claw-like to an elevation equal to that of the external cusps, and without cingula or appendicular cusps. First premolar with but one external and one internal cusps. Inferior molars seven, the true molars with five cusps, the anterior triangle distinct. Last inferior molar with a heel ; canine large.

Caudal vertebræ robust. Ilium rather slender, flat-triangular in section, and with a small anterior-inferior spine. Scapula with coracoid hook, and abruptly rising spine. Astragalus with unequal trochlear ridges, the internal the lower. Internal face oblique, but less so than in the species of Mioclænus where it is known, and not

produced farther posteriorly than the external face, which is vertical. Head depressed, convex, and without angles. Cuboid with a small external distal facet.

This genus is intermediate in character of teeth between Conoryctes and Mioclænus. The molars are those of the former as to the internal portion of the crown. The external cusps are more those of Mioclænus, and there is but one external cusp of the first premolar, while there are two in Conoryctes. It is in the remarkable table-like form of the interior part of the crown and the hoof-like production of the internal angle, that Onychodectes differs from Mioclænus.

But one species is known to me.

ONYCHODECTES TISONENSIS sp. nov.

Two individuals certainly represent this species in my collection, both of which include superior molars, while a third, which includes two mandibular rami, belongs to it. Of the former the typical and most important specimen includes the following parts. Both maxillary bones with the posterior five molars; the left mandibular ramus with all the alveoli, and the second true molar in place; the glenoid extremity of the scapula; the left ilium; the right astragalus and cuboid.

It is characteristic of the superior molars that the external cusps have a lenticular section, and not a triangular or a round one as in the species of Mioclænus and Chriacus. The external cusp of the first premolar is large and elevated, and has the same fore and aft lenticular section with obtuse cutting edges. The internal table of the crown is of parabolic outline and its edges are right angles. The sides ascend perpendicularly to the alveolar border without the least trace of cingulum or other irregularity. The crown has a weak external cingulum, which does not support any cusps. The posterior of the external cusps of the third molar is well developed, and nearly in longitudinal line with the anterior.

The anterior triangle of the second inferior molar has a broadly rounded external apex, and it is a little elevated above the heel. The latter has two internal marginal cusps, but its summit is so worn that the form of the surface cannot be further determined. No cingula. The manner of mastication is such as to wear the crown obliquely from within outwards in conformity with the form of the inner table of the superior molars. The anterior triangle fits, as usual, between two adjacent superior molars, and the claw-shaped internal border of the superior molar worked, scoop-like across the heel, the inferior molar moving from without inwards. The motion was the same as in Conoryctes. In neither genera do I possess the glenoid surface for the mandibular condyle, but it is highly probable from the evident lateral movement of the lower jaw that neither genus possessed a preglenoid crest as is found in Mioclænus.

The mandibular ramus is slender and moderately stout, especially so at the anterior base of the coronoid process. It follows that the anterior border of the masseteric fossa is well marked, but there is no distinct inferior border. The angle is prominent, straight, and compressed; apex lost. The dental foramen is below the middle of the base of the coronoid; and in line with the alveolar border. The symphyseal surface is smooth. The fourth premolar is close to the canine, and to the third, and has one root. Premolars all closely contiguous. From the appearance of the alveoli the last inferior molar is of reduced size. Enamel everywhere smooth.

Measurements; from one individual.	*M.*
Length of posterior five molars	.021
" " true molars	.0155
Diameters p. m. i: anteroposterior	.005
Diameters p. m. i: vertical, outside	.004
Diameters p. m. i: transverse	.006
Diameters m. ii: anteroposterior	.0055
Diameters m. ii: vertical, inside	.005
Diameters m. ii: transverse	.0075
Diameters m. iii: anteroposterior	.0042
Diameters m. iii: vertical, inside	.0042
Diameters m. iii: transverse	.006
Length of inferior molar series	.041
" " true molar series	.021
Diameters m. ii: anteroposterior	.007
Diameters m. ii: transverse	.0045
Depth ramus at m. iii	.015
" " " p. m. iii	.014
Diameters glenoid cavity of scapula: anteroposterior	.016
Diameters glenoid cavity of scapula: transverse	.011
Diameters peduncle of ilium: anteroposterior	.012
Diameters peduncle of ilium: transverse	.009
Greatest diameters of astragalus: anteroposterior	.021
Greatest diameters of astragalus: transverse	.017
Width of trochlea	.0125
" " head	.011
Length of cuboid	.012

The specimens are all from the lowest beds of the Puerco.

MIOCLÆNUS Cope.

Proc. Amer. Phil. Soc., 1881, p. 489; 1883, p. 547; Tertiary Vertebrata, 1885, p. 324.

An examination of my material of species allied to the types of this genus results in the following conclusions:

The fifth or anterior inner cusp of the inferior molars in this genus, displays various conditions of development down to absence. In the species which I formerly

referred to Sarcothraustes it is well developed, although small and conic in shape, and occupies an elevated position on the inner side of the front of the crown, close to the fourth cusp. In the *M. interruptus*, it is less distinctly developed, and is wanting from the last molar in some of the specimens. In *M. acolytus* the fifth cusp adheres closely to the fourth, and is in some specimens wanting. In the *M. subtrigonus* the fifth cusp is indifferently absent, or present in small development on the second and third molars. In nearly all the species of the genus as here constituted the fifth cusp is present on the first inferior true molar; but in the *M. turgidus* and species most nearly related, it is absent. The species of the latter type differ from the forms allied to *M. coryphæus* and *M. ferox* in their robust premolars, but the *M. opisthacus* furnishes a passage between the two. It does not seem practicable to divide the genus, as I once proposed,* on the presence or absence of an interior cusp of the third superior premolar. While this cusp is present in the *M. turgidus*, it is wanting† in the nearly allied *M. zittelianus*, and the *M. opisthacus*.

In the species referred to the second section of the genus (Goniacodon, type *M. levisanus*), the fifth cusp is quite distinct, but is median in position and near the base of the crown (except in *M. heilprinianus*), forming an anterior angle in the outline of the crown. These species I have referred sometimes to Triïsodon and sometimes to Diacodon, but I think I have now found their proper position.

With six new species now added, the total of those embraced in the genus is twenty-four.

Parts of the skeleton of *M. antiquus*, *M. coryphæus*, *M. levisanus*, *M. floverianus*, *M. corrugatus* and *M. ferox* are preserved, and do not present any but specific differences. I must here correct an error into which I fell in describing the *M. ferox* (Tertiary Vertebrata, p. 331) in calling the fibula the radius (Plate XXIV f, fig. 11). The distal part of this element is very robust in that species.

I. Inferior true molars with anterior triangle of three cusps (*Sarcothraustes*).

Length of inferior premolars, .069; depth of ramus at p. m. iv, .055; superior true molar ii, .022 by .016, *M. antiquus*.

Inferior true molars, .052; premolars, .043; infer. m. iii, .015; depth of ramus at m. i, .052; length sup. true molars, .040..... *M. conidens*.

Inferior true molars, .037; premolars, .047; depth ramus at p. m. iv, .041..... *M. bathygnathus*.

Last inferior true molar, .012; depth of ramus at m. ii, .036..... *M. crassicuspis*.

Inferior molars, .037; m. iii, .012; premolars, .037; sup. molars, .030; depth ramus at m. iii, .027..... *M. coryphæus*.

Inferior molars, .030, wide; premolars, .030, close together, the first subconic; ramus at m. i, .020..... *M. pentacus*.

Superior molars, .020; depth ramus at inferior m. ii, .025..... *M. gaudrianus*.

Inferior true molars, .019; premolars, .018, the anterior spaced, the first anteroposteriorly short; depth ramus at m. i, .012..... *M. interruptus*.

Inferior true molars, .018 with anterior elevated ledge and basin-like heel; depth at m. i, .014..... *M. lydekkerianus*.

* Proc. Amer. Phil. Soc., 1883, p. 312. † Genus Oxyclænus Cope, l. c.

Inferior molars, .017; the first small, the last large, .0065; depth of ramus at m. i, .012.....*M. filholianus.*
Inferior molars, .011; fifth lobe small, heel with one cusp; depth ramus at m. ii, .007.....*M. acolytus.*

II. Inferior true molars with anterior inner tubercle submedian and depressed (*Goniacodon*).

Inferior true molar i or ii, .011; fifth cusp elevated, inner edge of heel crenate .....*M. heilprinianus.*
Inferior true molars, .0115; anterior paired cusps much elevated; last molar elongate, .007.....*M. assurgens.*
Inferior true molars, .022; last inferior and superior molars reduced, the inferior, .007.....*M. levisanus.*
Inferior true molars, .040; last molar large, estimated, .012; ramus deep; fifth cusp low, heel not crenate inside *M. rusticus.*

III. Inferior true molars (except first) without anterior inner fifth tubercle (*Mioclænus*).

A Premolars of smaller diameters than true molars.

α Heels of inferior molars supporting cusps.

ββ Superior molars subtriangular, rounded at inner angle.

Superior true molars wide, .017, with small tubercle between external cusps, and strong posterior internal cingulum; inferior molars, .023; depth of ramus at m. i, .012. .....*M. subtrigonus.*
Superior true molars, .019; external cusps close together and without intermediate cusp.....*M. cuspidatus.*
Superior true molars wide, .021; inferior molars, .025; premolars, .025; depth of ramus at m. i, .015, *M. protogoniöides.*
Inferior true molars, .028, the anterior with a strong anterior fifth cusp.....*M. floverianus.*

αα Heels of inferior molars bounded by a curved crest (anterior inferior true molar with median anterior fifth cusp).

Enamel wrinkled; length of ramus, .110; depth at m. i, .020; true molars, .035; premolars, .035.....*M. corrugatus.*
Enamel roughish; length of ramus, .160; depth do. at m. i, .034; true molars, .038; premolars, .041.....*M. ferox.*

AA Superior or inferior premolars of equal or greater transverse diameter than the true molars.

α Heels of inferior molars supporting cusps.

Last superior premolar with large internal cusp; superior molars, .013; inferior molars, .016; premolars, .019; depth ramus at m. i, .010; last molar large.....*M. opisthacus.*

αα Heels of inferior molars supporting a curved crest from an external cusp (last molars small; no fifth cusp on inferior m. i).

Cusps obtuse, premolars swollen; superior molars, .018; premolars, .029; superior p. m. iii and iv, with internal cusps; depth of ramus at m. i, .012.....*M. turgidus.*
Like last but smaller, and internal cusp wanting on superior p. m. iii, and rudimental on p. m. iv; superior molars, .015; premolars, .022.....*M. zittelianus.*
Much smaller; inferior molars, .0125; depth of ramus at m. i, .007; exterior cingulum of superior molars strong; premolars in both jaws large; heel of lower molars with high edge.....*M. turgidunculus.*
Still smaller; superior molars, .008, with strong external cingulum; premolars not enlarged; inferior m. iii not much smaller than m. ii.....*M. acolytus.*
Small; superior molars, .010; without external cingulum; intermediate tubercles very indistinct; inferior m. iii much smaller than m. ii; premolars small.....*M. minimus.*

MIOCLÆNUS BATHYGNATHUS sp. nov.

Established on a nearly entire left mandibular ramus which supports the true molar teeth and the second premolar. The species is distinguished at first sight by the relatively large size of the ramus, as compared with the dimensions of the true molars. The latter do not exceed in size those of the *M. ferox*, but the jaw is that of an animal as large as the *M. conidens.*

The ramus is of compressed form, and is rather thin posteriorly. It is deepest below the first true molar. Symphyseal suture very coarse. Coronoid process large.

The condyle is broken off, but it was probably elevated a little above the line of the molars. Masseteric fossa well defined anteriorly, but not inferiorly. The angular region is perfectly flat and straight. The dental foramen is below the middle of the coronoid process, and just below the line of the bases of the crowns of the molars. Mental foramina two, in horizontal line.

The inferior canine was large and compressed; part of its alveolus only remains. The molars and premolars are small. The crowns of the fourth and third premolars are lost, but judging from the extent covered by the two roots of the third, it is as large as or a little larger than the second. The second has a simple slightly compressed conical crown, with a small posterior transverse heel. The first premolar is a large tooth, and judging from the alveoli, of greater anteroposterior extent than any of the true molars. The true molars are somewhat worn with use. The anterior part of the crown is more elevated than the posterior, offering in this a resemblance to the *M. conidens*, and a contrast to the *M. corrugatus* and *M. ferox*. The fifth cusp is entirely on the inner side of the crown, and is close to the fourth, which it did not equal in elevation when unworn. The heel of the third molar is short so that the length of the crown does not exceed that of the second true molar, which is the most robust of the series. There is a cingulum on the external base of the true molars, and another on the internal base of the anterior half of the crown of the same. The enamel is minutely rugose.

Measurements.	*M.*
Estimated length of ramus to below condyle	.185
Depth at m. i	.044
" " m. iii	.040
Width at base of coronoid in front	.015
Length of molar series	.081
" " true molars	.037
Diameter of canine alveolus (greatest)	.020
Diameters base of p. m. i { anteroposterior	.0145
Diameters base of p. m. i { transverse	.009
Diameters m. i { anteroposterior	.011
Diameters m. i { transverse	.0095
Diameters m. ii { anteroposterior	.0125
Diameters m. ii { transverse	.010
Diameters m. iii { anteroposterior	.0125
Diameters m. iii { transverse	.0095

From the lowest bed of the Puerco of New Mexico. D. Baldwin.

If the skull of this animal was proportioned as in allied forms it was about the size of that of the black bear (*Ursus americanus*).

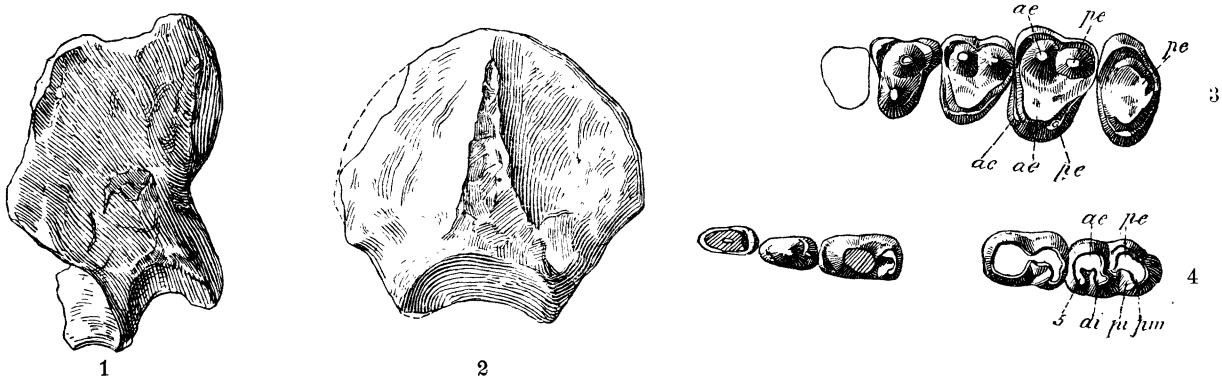
MIOCLÆNUS CRASSICUSPIS Cope. *Conoryctes crassicuspis* Cope; Tertiary Vertebrata, 1885, p. 201, Pl. xxiii e, fig. 6.

Better specimens of the *Conoryctes comma* and of this species show that there is nothing in common between them. The *M. crassicuspis* is allied to the *M. coryphæus*, but has a deeper ramus of the mandible and was probably a considerably larger animal. The last inferior true molar is relatively of smaller size than in that species. Parts of lower jaws of three individuals are in my collection. These show that the fifth cusp is well developed in all of the true molars, and that the anterior part of the crown is higher than the posterior. The type and a second specimen are from the Lower Puerco; the exact horizon of the other is unknown.

MIOCLÆNUS CORYPHÆUS Cope. *Sarcothraustes coryphæus* Cope; Amer. Naturalist, 1885, p. 386.

Nine individuals represent this species in my collection. The best of these includes numerous fragments of a skull with superior molar teeth, and a part of the mandible with the second true molar in a worn condition. The mandibular rami of other individuals furnish the entire inferior series.

The crowns of the superior molars support two external conical cusps which stand close together, but are entirely distinct, and have a circular section. There is a single internal conical cusp flattened on the external side. The entire crown is sur-



Mioclænus coryphæus.—Fig. 1. Right squamosal bone, from within. Fig. 2. Occipital from front. Fig. 3. Left superior molars, lacking p. m. ii, iii and iv. Fig. 4. Inferior molars lacking m. i, and p. m. iv. All from the typical individual except p. m. i, ii, and iii. Figs. 1–2, seven-ninths natural size; 3–4, about natural size.

rounded by a well-developed cingulum, which is especially prominent round the external anterior cusp of the second and third true molars. The posterior external cusp of the last true molar is rudimental, and is situated well within the external line on the posterior border. The fourth premolar has a single external cusp, and the cingulum is wanting on the anterior and interior sides. The outline of the base of the crown

of this tooth is subtriangular; that of the first and second true molars is a half ellipse; while that of the last true molar is a transverse oval, as in the two species mentioned above. In this last respect it differs from the species of Mesonyx and Dissacus, where that tooth has a triangular base. Enamel delicately wrinkled where unworn. In the *M. antiquus* and *M. conidens*, the first and second true molars have a triangular outline, and there is no internal cingulum.

The occiput of this species rises into an elevated transverse crest with an oval outline, like that of the Dinocerata. This is divided in front by an elevated sagittal crest. The brain cavity is very small. There is a preglenoid crest.

Measurements of Superior Molars.		*M.*
Length of true molars		.031
Diameters of p. m. iv	anteroposterior	.010
	transverse	.012
Diameters of m. ii	anteroposterior	.011
	transverse	.016
Diameters of m. iii	anteroposterior	.008
	transverse	.015
Elevation of occipital crest		.058

The ramus of the mandible has a low and elongate form, and is not very robust. The inferior outline rises below the coronoid process, and the angular region is narrow and compressed. The condyle is produced posteriorly, and its articular face is recurved backwards, and downwards, contracting to an obtuse angle. Its radial line is directed nearly posteriorly. The posterior border of the ramus is concave immediately below it. The dental foramen is below the middle of the coronoid process. The mental foramen is single and is below the p. m. iii. The symphyseal suture is coarse.

The canine tooth is of moderate size (crown broken off). The fourth premolar is one-rooted. The third and second are two-rooted. They are of equal size and small; much smaller than the p. m. i. Their crowns are low, compressed-conic, with a small anterior cingulum and a short carinate heel. The p. m. i is as long anteroposteriorly as any of the molars. Its crown consists of a large compressed-conic cusp directed somewhat obliquely backwards, and a heel supporting two closely-appressed conic cusps. The internal of these is a little posterior to the external; the latter is slightly extended towards the principal cusp. There is a low anterior basal cusp. The anterior part of the true molars is more elevated than the posterior. It consists of three tubercles as already described. The heel supports three cusps; a large external, which has a crescentic section; a minute median, and an anteroposterior interior, which is of medium size, and little elevation. The third true molar differs in having

the median tubercle as large as the external, thus developing a heel. There is a low basal cingulum on all the true molars on the external side, but none on the inner side. The external side of the heel of the p. m. i has a low cingulum. The enamel is minutely rugose, but is worn nearly smooth in old examples.

Measurements of Ramus.	*M.*
Total length	.150
Length of dental series	.088
" " molar "	.073
" " true molar series	.037
" " p. m. i	.0013
Diameters m. i { anteroposterior	.0105
Diameters m. i { transverse	.008
Diameters m. ii { anteroposterior	.0125
Diameters m. ii { transverse	.009
Depth ramus at m. i	.028
" " " m. iii	.028
" " from summit of condyle	.036
Width of coronoid process at anterior base	.015

The mandible from which the above description is taken is that of a different individual whose cranial characters are given on a previous page.

All the specimens are from the Lower Puerco beds.

MIOCLÆNUS PENTACUS sp. nov.

Represented by mandibular rami of seven individuals, which display all the molar teeth except the fourth, which is represented by its alveolus. The character of these teeth is a good deal like that of the *Protogonia puercensis*, but the absence of superior molars prevents my learning whether the species is one of the Phenacodontidæ or not. If it is, it belongs to a genus of that family hitherto undescribed, since the first premolar is absolutely simple, or without internal cusp. This fact prevents my reference of the species to the genus Chriacus, to which the details of the structure of the true molars have much resemblance. My reference of this species to Mioclænus is therefore purely provisional. The very robust form of the first premolar resembles that of the *Haploconus entoconus* rather than that of any species of Mioclænus.

The inferior molars are robust and Phenacodus-like, but the fifth cusp is well developed in all of them, forming an anterior triangle. The three cusps of this triangle are only connected at their bases. The heel is wide and supports a large external marginal cusp and a curved raised margin behind and within, which is notched at two points so as to produce two narrow areas on wear. On the third true molar these are represented by distinct but rather small tubercles. The second true molar

is distinctly larger than the first or the third. The external tubercles of all of the true molars stand within the base of the crown, so that their external faces are unusually oblique. They have a crescentic section, and the posterior sends its anterior ridge obliquely to the base of the posterior of the anterior internal cusps, enclosing a basin as in Chriacus. There is a delicate cingulum round the base of the crown on all except the internal sides. The first premolar is a robust tooth, with a wide narrow heel, and a small anterior basal tubercle, besides the principal subconic cusp. A delicate external basal cingulum. The third premolar has a minute heel, and no external or anterior cingulum. Fourth premolar one-rooted. A short space between third and fourth premolars. Enamel minutely rugose, but polished.

The ramus is not deep, but is robust. Its inferior outline rises posteriorly from below the anterior part of the third true molar. The anterior masseteric ridge is prominent. The coronoid process rises gradually from the third true molar, without carrying that tooth with it. The symphysis extends posteriorly to the line of the posterior border of the third premolar. Mental foramina below the second and fourth premolars.

Measurements.		*M.*
Total length of inferior molar series		.060
Length of true molars		.030
Diameters p. m. i	anteroposterior	.008
	transverse	.0065
Diameters m. i	anteroposterior	.0096
	transverse	.0083
Diameters m. ii	anteroposterior	.0105
	transverse	.0098
Diameters m. iii	anteroposterior	.0105
	transverse	.0083
Depth ramus at	p. m. i	.019
" " "	m. iii	.021

The seven individuals represented in my collection are all from the Lower Puerco, and the species is probably confined in its range to that horizon.

MIOCLÆNUS GAUDRIANUS sp. nov.

In this species we have a form which in various respects suggests approach to Onychodectes. It is represented in my collection by several fragments of the skull of an individual of medium dimensions in the genus. Both maxillary bones are preserved with most of the molar teeth, and a part of the mandible with the last molars.

The first superior premolar has the principal cusp an acute cone with the section but little compressed. It is joined to an internal cusp whose apex is crescentic.

Externally it is bounded by a strong cingulum whose anterior and posterior extremities rise into strong basal tubercles of crescentic section. The first true molar is considerably smaller than the second, and has a strong posterior inner cingular tubercle, but no internal cingulum. The second true molar has the structural characters of the first. Its external cusps are conic, and are little compressed. There is a strong external cingulum, but no internal cingulum. The third true molar has a very small anteroposterior diameter, and has a very strong external cingulum which increases the transverse diameter of the crown. There are delicate anterior and posterior cingula, which are continuous round the internal base of the crown. In the lower molars the third is considerably smaller than the second, and its keel is but little produced. The anterior part of both molars is elevated above the posterior part.

The ramus mandibuli is characterized by the rapid increase of its depth anterior to the base of the coronoid process, and by the distance of the m. iii anterior to the base of the coronoid process. The anterior border of the masseteric fossa is not very strongly marked. The calcaneum has the form usual in Creodonta. The sustentaculum and internal facets are well spread apart, and the cuboid facet is triangular and oblique to the long axis of the bone.

Measurements.	*M.*
Length of bases of posterior six superior molars	.045
" " " true molars	.021
Diameters of p.m. i { anteroposterior	.007
Diameters of p.m. i { transverse	.008
Diameters of m. i (transverse)	.008
Diameters of m. ii { anteroposterior	.0075
Diameters of m. ii { transverse	.0105
Diameters of m. iii { anteroposterior	.005
Diameters of m. iii { transverse	.009
Length of inferior m. iii	.0085
Diameters inferior m. ii { anteroposterior	.009
Diameters inferior m. ii { transverse	.005
Depth of ramus at base of coronoid	.020
" " " front of m. ii.	.025
Length of calcaneum	.025
" " free calcar	.014

This species has molar teeth about the size of those of the *M. protogonioides*. In that species also, the second superior true molar is larger than the first, but the third is relatively larger than in the *M. gaudrianus*, having two well-developed external cusps. The ramus mandibuli of the *M. protogonioides* does not increase in depth anteriorly, and the inferior m. iii is larger. There is no fifth cusp on the molars.

This species is dedicated to my distinguished friend Prof. Albert Gaudry, Professor of Palæontology in the Jardin des Plantes, Paris. The type specimen comes from the Lower Puerco.

MIOCLÆNUS INTERRUPTUS Cope. *Deltatherium interruptum* Cope, Proc. Amer. Philos. Soc., 1882, p. 463; Tertiary Vertebrata, 1885, p. 282, Pl. XXIII d, fig. 13.

The type and only specimen of this species is imperfect, but presents the character which is shared by no other in this genus, of interspaces between the second, third, and fourth inferior premolars. The fourth premolar is not present in the specimen, whence my former reference of the species to the genus Deltatherium, but the appearance of the surface of the ramus leads me to suspect that the tooth has been lost by accident. The species is further peculiar in the very small anteroposterior diameter of the first premolar, in which it differs from the other species where this tooth is known. The fifth cusp is well-developed on the m. i, but the other inferior molars, with the superior dentition, are unknown.

MIOCLÆNUS LYDEKKERIANUS sp. nov.

This species is characterized by the presence on the inferior molar teeth of a distinct curved ledge in front of the two principal anterior cusps, which terminates in a more or less distinct fifth cusp at its internal extremity. The ledge with its curved anterior edge is unusual in this genus, though more or less developed in some of them, especially the *M. opisthacus*. The present species is much larger than the latter, and exceeds the *M. subtrigonus* also, but is smaller than the *M. protogonioides*.

The heel is rather wide and the edges elevated and with only an external cusp-like elevation, giving a basin-like surface. The last molar is not enlarged or reduced, but is narrower than the m. ii. The crowns are without cingula, and the enamel is obsoletely plicate. No premolars preserved.

Measurements.		*M.*
Length of true molars		.018
" " last true molar		.007
Diameters m. ii	anteroposterior	.006
	transverse	.006
Diameters m. i	anteroposterior	.0055
	transverse	.0055
Depth of ramus at m. i		.014

Portions of three mandibular rami represent this species. It is dedicated to Dr. Richard Lydekker, the distinguished curator of vertebrate palæontology in the British Museum.

MIOCLÆNUS FILHOLIANUS sp. nov.

Parts of both mandibular rami of two individuals represent this species in my collection. One of these presents the five posterior molars in perfect preservation. The characters ally the species to some of those of Chriacus, but the simple first inferior premolar distinguishes it from that genus. After the *M. minimus* and the *M. acolytus* this is the smallest species of Mioclænus, and its inferior molars have the cusps more acute and elevated than in any other.

The molars are distinguished from those of several other species, including *Chriacus schlosserianus*, in that they increase in size, regularly posteriorly. The first is thus much smaller than the third, a proportion which is reversed in many other species. The two anterior cusps are joined much above the level of the heel, which would be thus much below them, but for the fact that its border is much elevated, leaving the median surface a deep basin. The fifth cusp is small and is elevated and close to the fourth, and is connected with the anterior external by a curved crest. The edge of the heel is developed into three small cusps, one median and two lateral. The third true molar is quite elongate, and has six well-developed cusps in all. The first premolar has a short base, and the principal cusp is truncate behind, and has a sharp edge in front. The heel is very short and terminates in a small acute cusp, and there is no anterior basal cusp. The second premolar has a small cuspiform heel. There is a weak cingulum on the first premolar and first true molar, but only traces remain on the m. i and ii. Enamel smooth.

Measurements.		*M.*
Length of true molars		.017
Diameters of m. i	anteroposterior	.0045
	transverse	.003
Diameters of m. ii	anteroposterior	.0052
	transverse	.0035
Diameter of m. iii	anteroposterior	.006
	transverse	.0035
Depth of ramus at front of m. i		.012

The two specimens of this species were found in the lowest beds of the Puerco formation by Mr. David Baldwin. It is dedicated to Dr. Henri Filhol, the distinguished French palæontologist, whose discoveries in the field of extinct Mammalia have been so numerous and important.

MIOCLÆNUS PROTOGONIOIDES Cope; Amer. Naturalist, 1882, p. 833; Tertiary Vertebrata, 1885, p. 340, Pl. XXV f, fig. 17.

This species has been known hitherto by the last two superior molars only. At present I have in addition, a fragment of a maxillary bone with the first and sec-

ond true molars, and a set of jaws of a single broken skull, and also a left mandibular ramus containing all but the canine and fourth premolar teeth. The species is distinguished in the upper series by the relatively considerable development of the second and third superior molars, the third having two well-developed external cusps. Also by the strong development of the intermediate tubercles, and the distinctness of the posterior inner tubercle of the first and second true molars. Though distinct, it is only a small acute elevation of the posterior cingulum. The latter passes round the internal base of the second and third true molars, but not the first.

The ramus of the lower jaw is of moderate and uniform depth throughout, and not convex below, as in *M. gaudrianus*. The second and third true molars have no trace of the fifth cusp; the anterior part of the first is lost. There is a weak median posterior tubercle on the first and second true molars, which is developed into a very large obtuse heel in the third, so that this tooth is longer than either of the other true molars, and reaches to the base of the coronoid process. The first premolar is not relatively so large as it is in some of the species above described. Its principal cusp is but little compressed, and the heel is short and transverse, and has the inner extremity almost cuspidate. A small acute anterior basal cusp. The second premolar has anterior and posterior basal cingula only. The third is a little smaller than the second. The only cingulum of the inferior molars is at the outer base of the anterior half of the crown. This half is a little higher than the posterior half.

Measurements of Ramus.	*M.*
Length of true molar series	.0245
Diameters m. ii, anteroposterior	.0075
Diameters m. ii, transverse	.0065
Diameters m. iii, anteroposterior	.0095
Diameters m. iii, transverse	.006
Depth of ramus at end of m. iii	.019
" " " " " m. i	.016

MIOCLÆNUS FLOVERIANUS sp. nov.

This species is indicated by parts of two mandibular rami which display four of the molar teeth, with which were found the following bones of the skeleton: several vertebræ, parts of both humeri, distal end of radius, greater part of right ilium. These all appear to be parts of the same skeleton.

The first true molar has a well-developed fifth cusp which is median in position and larger and lower than the fourth cusp, from which it is well separated in position. There is no trace of fifth cusp on the other true molars, but there is a median posterior of small size on the m. ii. The last inferior molar is not reduced as in some spe-

cies, but is smaller than the penultimate, and has but a short heel. The first premolar is about the length of the first true molar. It is robust, and the cusp is a little compressed, but is flattened behind. The heel is very short and is convex posteriorly. A very small anterior basal cusp. The anterior part of the crown of the m. i is higher than the posterior, which only supports one tubercle, the external. The inequality between the anterior and posterior tubercles of the third true molar is unnoticeable. No cingula on molars or premolars.

There are two lumbar and one caudal vertebræ. The centra are depressed by pressure; arches lost. The caudal vertebra is one of the proximals. It is robust, and indicates a well-developed tail. The head of the humerus is extended in the direction of the greater tuberosity. The latter is large and truncate both proximally and externally; at the posterior external angle is a distinct *fossa m. teretis*. The bicipital groove is wide. The lesser tuberosity is bounded by an angle, which rises proximad and towards the greater tuberosity. The deltoid ridge extends to below the middle of the shaft. The internal condyle is large and compressed so as to be vertical; it is pierced vertico-obliquely by the large entepicondylar canal. The external epicondyle is very little prominent, and is mostly occupied by its fossa. The transverse extent of the condyles is not very great. The lateral borders of its posterior groove are sharp. The convexity of the roller is pronounced but not approaching an intertrochlear crest. The distal extremity of the radius is wider than deep and the outer side is truncate, so that the section of the shaft is a triangle. At the extremity the ulnar side is grooved, and above the prominent superior border of this groove is another, which is bounded above by a short robust flat ridge. The outlines of the scaphoid and lunar fossæ are distinct except where they pass into each other.

The ilium is robust, and at the peduncle the anterior or inferior face is nearly as wide as the interior. At the sacral articulation it is moderately expanded. The anterior inferior spine or tuberosity is moderately prominent, and is situated a considerable distance proximad of the acetabulum, opposite the narrowest part of the peduncle.

Measurements.		*M.*
Length m. i		.009
Width " posteriorly		.0065
Diameters m. ii	anteroposterior	.009
	transverse	.0075
Diameters m. iii	anteroposterior	.009
	transverse	.007
Diameters p. m. i	anteroposterior	.009
	transverse	.005
Length of centrum of lumbar vertebra		.022

Measurements.		*M.*
Diameters of head of humerus	long, with great tuberosity	.021
	short, " small "	.017
Least diameter of shaft do.		.005
Width of distal end do.		.025
" " condyles in front		.015
Diameters distal end of radius	transverse	.0105
	vertical	.009
Ilium anterior width of peduncle		.010
" external " " "		.014

This species is one of medium size in the genus. It is quite of the type of the *M. ferox* and *M. corrugatus*. Its inferior molar teeth are considerably larger than those of the *M. protogonioides*, and the last one is shorter in relation to its length. It is dedicated to Professor W. H. Flower, Director of the Natural History Department of the British Museum.

MIOCLÆNUS CORRUGATUS Cope ; Proc. Amer. Phil. Soc., 1883, p. 560 ; Tertiary Mammalia, 1885, p. 341, Pl. XXIV f, fig. 5 ; XXIV g, fig. 8.

The discovery of nearly entire mandibular rami of this species and of *M. ferox* enables me to determine the distinctive characters of the two species better than heretofore. While the true molar teeth in the two are of nearly equal size, or at least within the range of variation not unusual in a variable species, the mandibular ramus of the *M. corrugatus* is very much smaller every way than that of the *M. ferox*. The shortening influences the length of the premolar series, which is much shorter in the *M. corrugatus*, the teeth being crowded, while in the *M. ferox* they are (the second, third and fourth) separated by interspaces. An astragalus which accompanies the jaws of *M. corrugatus* is identical in character with that of the *M. ferox* but of smaller size.

MIOCLÆNUS OPISTHACUS Cope ; Amer. Naturalist, 1882, p. 833. *Hemithlæus opisthacus* Cope ; Tertiary Vertebrata, p. 407, Pl. XXV f, figs. 8-9.

The typical specimens of this species include parts of four mandibular rami with teeth, and a single superior molar, which is that of a species of Hemithlæus. The association of this superior molar with the mandibles cannot be demonstrated. I have subsequently received a mandibular ramus with nearly complete dental series, associated with a portion of a skull which contains the true molars and the first premolar in a perfect state of preservation. Everything inspires the belief that these are parts of the same animal. In addition I have parts of both rami of a sixth individual which support most of the teeth ; and a maxillary bone with m. ii, m. i and p. m. i, with parts of mandibles of a seventh, and mandibles of five other individuals.

This species exhibits characters intermediate between the types with robust premolars, and those with premolars of narrower and more angular form. The second superior premolar has no internal cusp and is trenchant, but the first has a very large internal cusp, whose base is as large as that of the external one, and which has slight anterior and posterior cingula, but no internal or external ones. It resembles the corresponding tooth of some of the Periptychidæ. The true molars are those of this genus, resembling those of the *M. subtrigonus*. The external cusps are distinct and not compressed. The crown is surrounded by a cingulum except on the internal side. The cingulum rises into a small cusp between the external cusps, and into a small but distinct posterior internal cusp. In the inferior series the first and second premolars are enlarged and have longitudinally oval bases; both have posterior heels,

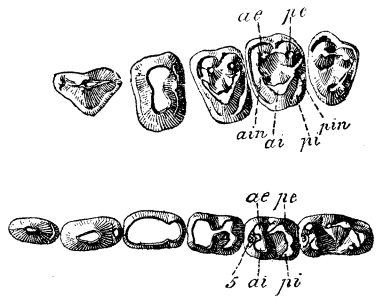


Fig. 5.

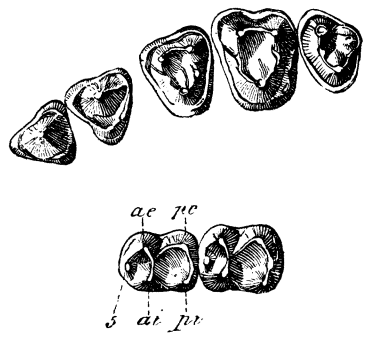


Fig. 6.

Fig. 5. *Mioclænus opisthacus* molars of both series $\frac{3}{2}$ natural size: the cusps are lettered; *ae*, anterior external; *pe*, posterior external; *ain*, anterior intermediate; *pin*, posterior intermediate; *ai*, anterior internal; *pi*, posterior internal; *5*, fifth cusp.

Fig. 6. *Chriacus priscus* $\frac{3}{2}$ natural size; teeth of both jaws.

and the first has a small anterior one; both are like those of Anisonchus. The inferior true molars illustrate the transitional condition of the fifth cusp in this genus. A narrow crest descends inwards from the anterior external cusp, but terminates below the level of the fourth, or opposite inner cusp, and there is no fifth cusp, or but a rudiment in the m. iii of one of the specimens.

Measurements of Fifth Specimen.	*M.*
Length of superior true molars	.014
Diameters of superior p. m. i { anteroposterior	.0045
Diameters of superior p. m. i { transverse.	.007
Diameters of superior p.m. ii (spec. No. 7) { anteroposterior	.006
Diameters of superior p.m. ii (spec. No. 7) { transverse	.004
Length of inferior molars (except p. m. iv)	.0335
" " " true molars	.0155
" " " p. m. i.	.0058
Width of inferior p. m. i.	.003
Length of inferior m. iii	.006
Width " " "	.003
Depth of ramus at m. i	.010

MIOCLÆNUS ZITTELIANUS sp. nov.

This species is represented by a skull which lacks the occipital region. It is enclosed in a silico-calcareous concretion, and the teeth have been cleanly exposed by weathering, but the surface of the skull is not cleaned. Large parts of both mandibular rami with their teeth are preserved.

The dental characters resemble those of the *M. turgidus*, but differ in the absence of internal cusps of the superior premolars. The dimensions are smaller, especially those of the premolar teeth. The last molar in both jaws is much smaller than the others, as in *M. turgidus*, and the intermediate tubercles in the superior molars are present, but small. The external cingulum is distinct on the superior true molars, but wanting on the premolars. The same is true of the anterior and posterior cingula, while internal cingula are absent from all the teeth. The heels are rudimental on the first and second inferior premolars.

Measurements.	*M.*
Length of superior molar series	.036
" " " true molars	.014
Diameters superior p. m. i, anteroposterior	.0055
Diameters superior p. m. i, transverse	.007
Diameters superior m. ii, anteroposterior	.0055
Diameters superior m. ii, transverse	.0072
Width between p. m. ii on palate	.0075
" " m. ii on palate	.015

From the Upper Puerco. Dedicated to Professor Karl Zittel, of the University of Munich, and Director of the Museum.

MIOCLÆNUS TURGIDUNCULUS sp. nov.

This species is primarily indicated by a portion of a left maxillary bone which supports the first two true molars, and the first premolar. There is a mandibular ramus supporting the corresponding teeth of the inferior series, which probably belongs to the same species, and the posterior parts of two other rami, each supporting the last two molars, are also referred to it.

The peculiarity of the superior molars consists in the strong external cingulum and intermediate tubercles, and the large size of the first premolar, and especially of its internal cusp, in which respects it resembles that of the *Mioclænus opisthacus*. It has no cingula whatever, except a trace at the anterior and posterior external angles. There are anterior and posterior, but no internal cingula of the true molars. In the *M. minimus* the molars have no cingula, except faint traces of the anterior and posterior, and the intermediate tubercles are wanting.

The inferior molars are referred to this species because of the large size of the premolars, which approach in dimensions those of the *M. zittelianus*. The first has a low wide heel, and no anterior basal angle. The fifth cusp exists as a cusp on the m. i and ii. The curved border of the heel in these teeth is more elevated than in the *M. minimus* on the inner side, so as to enclose a deep basin, which is much better defined than in *M. minimus*. In the third and fourth individuals, where the last inferior molar is preserved, this tooth is smaller than the m. ii, and both of these teeth have the fifth cusp present, but small, and appressed as a small twin on the anterior face of the fourth. This occurs also in the *M. acolytus*, and I do not believe that the character is constant.

Measurements.	*M.*
Length of superior molars (last estimated)	.011
Diameters m. ii { anteroposterior	.005
Diameters m. ii { transverse	.0055
Diameters m. i { anteroposterior	.004
Diameters m. i { transverse	.0045
Diameters p. m. i { anteroposterior	.0045
Diameters p. m. i { transverse	.006
Length inferior true molars (sp. 2)	.0125
" " p. m. i	.005
Depth ramus at m. ii	.0075

The typical specimen is from the lowest beds of the Puerco. D. Baldwin.

MIOCLÆNUS ACOLYTUS Cope. *Hyopsodus acolytus* Cope; Proc. Amer. Phil. Soc., 1882, p. 462; Tertiary Vertebrata, 1885, p. 238, Pl. XXIII d, figs. 5-6.

Additional specimens of this species show that it differs from the *M. minimus* in the presence of a strong external cingulum of the superior true molars, and the less reduced size of the last inferior molar. A single specimen, figured as above, displays the first two true molars and the first premolar above, and both the last inferior molars of the same skull. From the *M. turgidunculus* this species is easily distinguished by the small first and second premolars in both jaws. A damaged skull, without lower jaw, shows this character, as well as the type, and also that the fourth superior premolar has but one root, and is of small size; also that the canine is well developed and has a vertical direction. The second superior premolar has an internal cingulum, but no cusp.

Measurements of Skull.	*M.*
Length of superior dental series	.0252
" " " true molars	.009
Width between superior canines	.011

Five specimens; all from the Upper Puerco except one, and the specific reference of this one is uncertain.

The tritubercular superior molars and simple premolars show that this species cannot be referred to the genus Hyopsodus.

The number of the superior premolars of the allied *M. minimus* is unknown, so that it may be a Tricentes. In this genus it can be only compared with the *T. inæquidens* (Fig. 8), which is of about the same size. But in that species the last molar is still more reduced than in *M. minimus*.

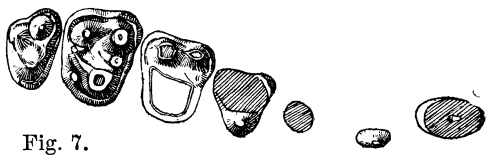


Fig. 7.

Fig. 7. *Tricentes bucculentus* $\frac{2}{1}$ natural size.

Fig 8.

Fig. 8. *Tricentes inæquidens* $\frac{5}{3}$ natural size.

CHRIACUS Cope.

Proc. Amer. Phil. Soc., 1883, p. 314; Tertiary Vertebrata, 1885, p. 740.

In the absence of sufficient knowledge of the skeleton in this genus I find its distinction from Mioclænus to rest on dental characters. It differs from that genus in the presence of an internal cusp of the first inferior premolar, which is however but little developed in some of the species. The molars of the inferior series may be usually easily distinguished from those of Mioclænus in the well-developed fifth cusp, and in the trihedral cusp of the external side of the heel, which with the raised internal border gives the heel the basin-like character which is seen in Pelycodus. The character of the inferior molars graduates into that of Mioclænus through such species as *M. subtrigonus* and *C. schlosserianus*.

The species are difficult to distinguish with the material in my possession. I recognize ten from the Puerco and one from the Wasatch. The former are distinguished as follows. Owing to the absence of corresponding parts I am obliged to compare the superior and inferior dental series in separate tables:

Species with Superior Molars.

I. Posterior cingulum and its interior cusp large, forming a prominent angle of the crown.

Larger; true molars .0185 ..... *C. pelvidens.*

Smaller; true molars .014 (Fig. 9) ..... *C. truncatus.*

II. Posterior cingulum and cusp small or insignificant.

a. Superior molars wider than long.

Largest; molars .0195; depth of ramus at m. i .012 ..... *C. priscus.*

Medium; molars .015; depth of ramus .011 ..... *C. schlosserianus.*

Smallest; molars .010; depth of ramus .007 ..... *C. simplex.*

aa. Superior molars longer than wide.

Medium; molars .0165 ..... *C. hyattianus.*

Species with Inferior Molars only.

I. Size large; premolars unknown.

Inferior true molars .0285; depth ramus at m. i .015 ..... *C. ruetimeyeranus.*

II. Size smaller; premolars not spaced.

Inferior true molars .023, last large; ramus .018 ..... *C. pelvidens.*

Inferior true molars .017, the last small, the first not reduced; ramus .011 ..... *C. schlosserianus.*

III. Size smaller; spaces between p. ms. ii, iii and iv.

True molars .018, fifth cusp very distinct from fourth; molar series .043 ..... *C. baldwini.*

True molars .024, fifth cusp divergent, connected with fourth by a crest; molar series .050 ..... *C. stenops.*

IV. Smaller; third premolar larger than second.

Depth of ramus at p. m. i .010 ..... *C. inversus.*

Fig. 9.

Fig. 9. *Chriacus truncatus* $\frac{3}{2}$ natural size.

Fig. 10.

Fig. 10. *Indrodon malaris* $\frac{5}{3}$ natural size.

CHRIACUS PRISCUS sp. nov. Fig. 6.

This species is represented primarily by a fragmentary skull of which there remain, the superior walls of the brain case, a part of the left maxillary bone, which supports the posterior five molars; part of the right maxillary with three molars, and part of the right mandibular ramus with the anterior two true molars. There are associated as cospecific with this individual, a second, represented by superior and inferior molars; a third represented by superior molars only, and two others represented by mandibular rami only; in all, five individuals. All are from the lowest beds of the Puerco.

The superior molars are of the same size as those of the *C. pelvidens*, but are very different in form. The absence of the strong internal angles of the crown at the inner extremities of the anterior and posterior cingula, is one character. The straight outline with an open margination of the external side of the crown in *C. pelvidens* is in strong contrast with the two convexities, each following an external cusp which form the outline in the *C. priscus*. The first premolar has a small internal cusp in the *C. priscus;* a large one in the *C. pelvidens*. It is represented by an angular cingulum in the *C. priscus*. In this species the cingulum does not extend round the inner base of the crown, except weakly in the last molar.

The inferior molars have a relatively greater transverse diameter than those of any other species of the genus. They also differ from those of the *C. pelvidens* and *C. stenops*, which they resemble in size, in the nearly equal elevation of the anterior and posterior cusps, and in the absence of an external basal cingulum. The fifth

cusp is a small cone, and is not spread away from the fourth and connected with it by a crest, as in *C. stenops.* In specimens with the last inferior molar preserved, that tooth is seen to be of average proportions.

The brain-case is long, narrow and rather low, and the sagittal crest is low and thin. It does not in the least resemble that of Adapis, but is rather that of a Creodont. Postorbital region lost.

Measurements.	*M.*
Length of five superior molars	.031
Diameters p. m. i { anteroposterior	.0055
Diameters p. m. i { transverse	.0055
Diameters m. ii { anteroposterior	.007
Diameters m. ii { transverse	.0085
Diameters m. iii { anteroposterior	.0055
Diameters m. iii { transverse	.0075
Diameters inferior m. ii { anteroposterior	.007
Diameters inferior m. ii { transverse	.0065
Diameters m. i { anteroposterior	.006
Diameters m. i { transverse	.006
Depth of ramus at m. i	.012

CHRIACUS SCHLOSSERIANUS sp. nov.

Parts of four individuals represent this species. Three of these are from the Upper Puerco; the exact horizon of the fourth is probably the same, as those from the Lower Puerco are especially marked in my collection. The typical specimen includes parts of both maxillaries with molars; both mandibular rami, one nearly perfect and supporting the last four molars; parts of both humeri, an ulna and part of the right astragalus. The species is smaller than the *C. priscus*, and has about the dimensions of the *Mioclænus subtrigonus.*

The posterior internal cingular cusp of the second superior molar is better developed than in the *C. priscus*, but nothing like that seen in the *C. pelvidens* and *C. truncatus.* The cingulum continues round the internal side of the crown in the second and third molars (first injured). External cingulum present. Last molar of relatively small size, about as in *Mioclænus turgidus*, but larger than in *Tricentes inæquidens.* Internal cusp of p. m. i small. The inferior series is distinguished by the small size of the third. The anterior part of the crown of the inferior molars has a distinctive character. The fifth cusp is not distinctly defined, but the anterior part of the crown forms a three-side prism, the anterior edge, or that connecting the external anterior cusp with the fifth, being very well defined. On wearing, the summit forms a narrow V with the apex external. External cingulum complete on the second true molar only. The first premolar is of moderate size, and has an anterior

cusp of an elevation equal to the internal cusp. There are no interspaces between the first, second and third premolars, and probably not behind the fourth, as the jaw is shallow and tapers rapidly. It is, however, deeper than in the *C. simplex*. Mental foramina below the second and fourth premolars.

There is nothing noteworthy in the humerus. The astragalus has but a short anteroposterior trochlear surface, and it extends well on the neck, indicating a plantigrade foot. It is slightly concave transversely. The malleolar face is oblique, and projects posteriorly beyond the fibular face, which is vertical. The base of the posterior notch bridges the minute median foramen. The ulna is much compressed, and has a large olecranon. The humeral cotylus is diagonal to the long diameter of the shaft, and has a marginal flange behind on the interior side, and in front on the exterior side. The radial face is absolutely flat and is directed inwards at an angle of thirty degrees from the vertical. It indicates a flat head of the radius, without rotary capacity. Below the superior border of the ulna, on the external side, is a deep groove which extends to the edge of the flange of the humeral cotylus.

Measurements.	*M.*
Length of superior true molars	.015
Diameters of m. iii, anteroposterior	.0062
Diameters of m. iii, transverse	.0035
Diameters of m. ii, anteroposterior	.006
Diameters of m. ii, transverse	.008
Diameters of p.m. i, anteroposterior	.0055
Diameters of p.m. i, transverse	.004
Length of inferior molars less m. i	.029
" " " true molars	.017
" " " molar iii	.0055
Diameters m. ii, anteroposterior	.0055
Diameters m. ii, transverse	.0045
Depth of ramus at m. i	.010
Width of distal condyle of humerus in front	.011
Diameter shaft humerus at middle, anteroposterior	.006
Diameter shaft humerus at middle, transverse	.007
Depth of ulna, at olecranon	.009
Depth of ulna, at cotylus	.0065
Depth of ulna, at coronoid	.009
Width of astragalus	.008
Width of trochlea	.005
Height of trochlea, external side	.0045

This species is dedicated to my friend Dr. Max Schlosser, of Munich, whose works on the extinct Mammalia are among the most important of modern times.

CHRIACUS RUETIMEYERANUS sp. nov.

This is the largest species referred to the genus, and is the only one as yet represented by a single individual. I possess part of the left mandibular ramus which exhibits the true molars, and the roots of the first and second premolars.

The last molar is as large as the second, and its anterior cusps are not opposite to each other as in other species of Chriacus, but the external is in advance of the internal. The fifth cusp is not elevated as in other species, but is represented by an internal angle of an interior ledge, which is quite wide. The anterior cusps of the m. i are opposite, those of m. ii are injured. The heel has the external cusp of crescentic section, and the internal elevated border. No cingula. Enamel obsoletely coarsely rugose. The heel of the m. iii is well developed, as are also the adjacent internal and external marginal cusps.

Measurements.		*M.*
Diameters m. i	anteroposterior	.009
	transverse	.005
Diameters m. iii	anteroposterior	.010
	transverse	.0055
Depth of ramus at posterior end of m. i.		.016
" " " " m. iii		.021

From the lowest Puerco beds. Dedicated to Prof. L. Ruetimeyer, the distinguished palæontologist of Basle.

CHRIACUS BALDWINI Cope. *Deltatherium baldwini* Cope; Proc. Amer. Phil. Soc., 1882, p. 463; Tertiary Vertebrata, 1885, p. 282, Pl. XXIII d, fig. 12.

Besides the type of this species, I have obtained since its description, the greater part of the mandibular ramus with teeth with several parts of the skeleton, of one individual, and both mandibular rami with most of the teeth of a third individual. Parts of the rami of a fourth individual may belong to the species.

The complete rami show that their anterior portions are produced, and that the premolar teeth in front of the second are spaced. The second and third are close together. The true molars themselves are a good deal like those of the *M. subtrigonus* with fifth cusp. The internal cusp of the first premolar is rudimental in this species. The premolars of the *M. subtrigonus* are not spaced. The fifth cusp is small, distinct, and not involved in a crest. There is a small median cusp of the heel. The first premolar has a distinct heel. The enamel of the molars is coarsely rugose, a surface which long use does not entirely smooth. No cingula in one specimen, but in the type and second specimen there is a rather weak one on the external side. The mandibular condyle is entirely above the level of the molars in sp. No. 3. The last inferior molar is not of reduced size. Ramus slender.

The femur of the second specimen is nearly perfect. The trochanters are well developed; the great extending proximad to the head, and connected by a curved ridge with the less. Third trochanter superior in position, its superior part overlapping the line of the inferior part of the lesser. Head without fossa or notch *ligamenti teris*. Rotular face elevated, wide, with equal borders and slight concavity. Condyles well separated.

Measurements of No. 2.	*M.*
Length of inferior molar series	.043
" " " true molars	.0205
" " " " m. iii.	.007
Depth of ramus at m. i.	.015
" " p. m. iv.	.009
Length of femur (greatest).	.098
Width at head	.022
" " middle of shaft (crushed)	.011
" " condyles	.017

CHRIACUS STENOPS sp. nov.

Four mandibular rami of three individuals represent this species. Two of the rami are entire to the base of the canine tooth. These show interspaces between the second and third and third and fourth premolars, not seen in such species as *C. pelvidens* and *C. schlosserianus*. It resembles in this respect the *C. baldwini*, but differs from it in characters already mentioned, and in its superior size. The internal cusp of the first inferior premolar is also much better developed.

The anterior cusps of the true molars are more elevated than the posterior, but the difference is not so great as in some other species. The fifth is a prominent angle, nearly in line with the fourth, and connected with it by a crest. The heel has an external angular cusp with crescentic section, well distinguished from an internal curved border which is connected with a small median posterior angle. This becomes a prominent cusp in the third molar, which is of average size. Molars with an external cingulum. Enamel coarsely and obsoletely rugose in unused specimens. The first premolar has a well-developed transverse heel, and anterior basal cusp. The second has the same, but of reduced proportions.

In a specimen (No. 3) cleaned by weathering, the posterior border of the symphysis is opposite the posterior border of the p. m. iii; the two mental foramina are below p. m. ii, and the space between p. m. iii and iv.

Measurements No. 1.	*M.*
Length of dental series including canine	.055
" " molar series	.049
" " true molar series	.024

Measurements No. 1.		M.
Diameters m. i	anteroposterior	.0073
	transverse	.0055
Diameters m. iii	anteroposterior	.008
	transverse	.0055
No. 3.		
Length of premolar series		.026
Depth of ramus at m. i		.013
" " " " p. m. iv		.008

All the specimens of this species are from the Upper Puerco.

CHRIACUS INVERSUS sp. nov.

The characters of this species are so well marked that I introduce it here, although the material representing it is slight, a portion of a single mandibular ramus which supports three premolars, and one true molar. The posterior part of a ramus accompanies this specimen and may belong to the same species. But of this there is doubt.

The first premolar has a well-developed interior cusp, and a large heel. The latter has an internal vertical, and an external oblique side, terminating in a cutting edge, the internal curving round the posterior border to meet the external. There is no anterior basal cusp, nor any cingulum. The second and third premolars are compressed, and have cutting edges before and behind. The second has the heel slightly transverse, and a mere trace of anterior basal lobe. The third is larger than the second and is more compressed. Externally its face is regularly convex, but internally its convexity is a vertical median rib, and in front of this the face is concave, thus maintaining the acuteness of the anterior cutting edge on wear. The heel is small and compressed; anterior lobe none. The enamel of all the teeth is smooth. No cingula.

Measurements.	M.
Length of posterior three premolars	.015
" " p. m. iv	.007
Width " " "	.0038
Depth of ramus at front of m. i	.0115

TRIÏSODON Cope.

Amer. Naturalist, 1881, p. 667; Tertiary Vertebrata, 1885, p. 270.

But one species of this genus is described, although several have been referred to it. All but the type species have found a congenial location in the genus Mioclænus (group Goniacodon). I am now able, however, to add a second species of typical form.

TRIÏSODON BICULMINATUS sp. nov.

Parts of the mandibular rami of two individuals indicate this species. One of these supports the first and second true molars, and the other the first true molar only. The character of the genus is seen in the great development of the external cusp of the heel, and the absence of an internal cusp, so that the heel appears to have one cusp with an oblique cutting edge, resembling in this respect Palæonyctis. The two principal anterior cusps are opposite each other and united for half their elevation, and the internal is larger relatively than in the *T. quivirensis*. The fifth cusp is low, forming a distinct tubercle in the first molar only, and represented by the internal angle of an anterior ledge in the second. The heels of both the molars have three small tubercles on the posterointernal border, which are not so much elevated as the corresponding ones in the *T. quivirensis*. A weak external cingulum only. Enamel obsoletely coarsely rugose with minute tubercles.

Measurements.		*M.*
Diameters m. i	anteroposterior	.011
	transverse	.008
Diameters m. ii	anteroposterior	.012
	transverse	.0095
Depth of ramus at m. i		.020

From the bottom of the Puerco beds.

DISSACUS Cope.

Amer. Naturalist, 1881, p. 1019; Tertiary Vertebrata, 1885, p. 344, 741.

Numerous pieces of the skeleton associated with molar teeth which agree with those of the *D. navajovius*, throw much light on its characters, and on the position of the genus Dissacus. In the first place the zygapophyseal articulations of the lumbar vertebræ are of the involute type common to all the Creodonta. This is also determinable from the specimen described by me in the Tertiary Vertebrata, p. 741. In the new skeleton the fragments of metapodials, probably metatarsals, furnish evidence of the existence of five digits, which distinguishes the genus from Mesonyx, where there are but four. The astragalus is especially interesting in its relation to that of Mesonyx. It has, as in that genus, a distinct cuboid facet, separated from that of the navicular by an angle, but the angle is not as well defined as in Mesonyx and Pachyæna. The trochlea is very slightly concave, thus differing widely from that of the Mesonychidæ, and resembling that of other Creodonta. This bone therefore furnishes a clear guide to the phylogeny of the Mesonychidæ. The two facets are well defined on the proximal extremity of the cuboid. Its distal extremity supports but one, a

concave facet. The tubercalcis, like the olecranon, is elongate. The coracoid is distinct but short. The peduncle of the ilium is wide. The odontoid process is rather long and cylindric. There is an entepicondylar foramen, as in Pachyæna.

DISSACUS NAVAJOVIUS Cope, loc. cit.; Tertiary Vertebrata, Pl. XXV c, fig. 1.

The paradiapophysis of the atlas has the base extended throughout the vertebra anteroposteriorly, and the vertebrarterial canal divides it anteroposteriorly, issuing at about the middle of the superior surface. The atlantal articular surfaces of the axis are distinct from those of the odontoid. The floor of the neural canal has a low median convex ridge, which extends to near the end of the superior side of the odontoid process, from which it is separated, as well as from the articular faces below, by a shallow groove.

The glenoid cavity of the scapula is an oval, gradually acuminating to the narrow origin of the coracoid. The spine originates abruptly a little posterior to the middle line. In the humerus the entepicondyle is of moderate dimensions, much larger than in Mesonyx, but less prominent than in many other Creodonta. Outside the roller of the condyle there is a distinct border facet, rising to its external border, which is present in Mesonyx, but is wanting in Oxyæna. The roller is distinctly convex. The internal flange is well developed. In the ulna, the olecranon is long, straight and compressed. Its inferior border is of uniform width from below the glenoid surface to the extremity, and is but little in excess of that of the shaft further forwards. The posterior flange for the humerus is not present on the external side of the glenoid surface. The radial facet is not very oblique, and it is followed distally on the external side by a deep groove, which runs out on the external side of the shaft. The latter is marked by a deep and wide longitudinal gutter on its internal side, which is bounded by a narrow edge above, and a wide border below. It runs out on the inner side of the shaft proximally, opposite the middle of the external groove. This gutter is wider and deeper in this species than in any creodont known to me, excepting the *Pachyæna ossifraga*. The head of the radius is a depressed oval, with three articular surfaces; a median concave, and a narrower reflected bevel at each end, fitting corresponding faces of the humerus. The inferior ligamentous fossa is wide and shallow.

The femur is not preserved excepting the head, which shows a rather shallow fossa ligamenti teris, which is well separated from the border. The astragalar face of the tibia is quite oblique, especially next to the fibular suture. The internal malleolus is large, vertical, truncate and furnished with a tuberosity in front of the distal extremity. The articular surface is folded back over the anterior edge for a short

distance on the anterior face, to correspond with the fossa of the neck of the astragalus. The astragalus is somewhat depressed, and is quite oblique to the vertical plane. The neck is of moderate length, and is depressed, and the navicular facet slopes at an angle of forty-five degrees when the astragalus rests on a plane surface. The long axis of the trochlea slopes at an angle of thirty degrees to the long axis of the entire bone, outwards and forwards. The posterior foramen is completely enclosed. The malleolar face is oblique, the fibular vertical. The articular surface of the trochlea is continued in an excavation of the neck to its middle, and is terminated by an acute recurved boundary. This indicates a foot frequently held at right angles to the leg, and a plantigrade walk. The obliquity of the astragalus, which fits the tibia perfectly, means that the hind legs diverged to the feet in a very obvious manner. If the calcaneum is placed on a plane surface this divergence is still greater, since the calcaneum is obliquely related to the astragalus, as the latter is to the tibia. The animal may have, however, walked on the external edge of the foot. The sustentaculum is not very large as compared with the cuboid facet. The latter is trapezoid in outline, the four sides all unequal, being related as to length in the following order, beginning with the longest—inferior, superior external, superior internal, internal. When the astragalar facets are held in a horizontal plane, the long axis of this face is horizontal. In this position, the inferior surface of the calcaneum is a narrow obtuse ridge, bounded on the external side by a wide deep gutter. This is bounded above by an angular border of a narrow superior-external face, which widens posteriorly. The superior surface is an obtuse ridge. The internal surface is undivided by groove or ridge and slopes outward below. The inferior ridge terminates in an acumination at the inferior border of the cuboid facet. In front of the astragalar facets, the superior face of the calcaneum has three longitudinal fossæ separated by low ridges. The internal, which is in front of the sustentacular, is twice as large as any of the others. A transverse section through the middle of the cuboid bone is irregularly triangular. The external face is smooth. On the inferior face the large tuberosity is flattened, and is subquadrate in outline. It is separated from the edge of the metatarsal facet by a groove which is, however, *closed at both ends*, indicating that it has not a pulley-like function for the usual tendon. On the interosuperior face we have proximally a smooth band for the navicular, and about the middle, an oval facet transversely placed for the ectocuneïform. The cuboid and navicular do not then present in different directions as they do in Oxyæna, but in the same direction, as in Mesonyx.* The ectocuneïform is deeper than long, and longer

* Scott, On New and Little Known Creodonts, Jour. Phil. Acad., 1886, p. 163.

than wide. The cuboid facet is continuous, at a right angle with the navicular facet. The metatarsal facet is simple, and is anteroposteriorly concave. There are two distal mesocuneïform facets, and one proximal which is turned down for a short distance in front.

The *Dissacus navajovius* is a smaller species than any of the other Mesonychidæ, and is especially interesting in view of the ancestral characters which it displays. It shows that the specialization of the extremities which has occurred in the Carnivora has taken place in this line also, in the progressive digitigradism; the reduction of the digits; the development of a trochlea of the ankle-joint; and the loss of cusps from the molar teeth.

Measurements.	*M.*
Length of base of paradiapophysis of atlas	.016
" " odontoid process of axis	.009
" " atlantal facet of axis	.013
" " centrum of lumbar vertebræ	.018
Diameters glenoid cavity of scapula { anteroposterior	.020
Diameters glenoid cavity of scapula { transverse	.014
Transverse diameter condyles humerus in front	.017
Anteroposterior diameter of flange of do	.015
Length of olecranon	.028
Depth olecranon at middle	.015
" ulna at glenoid cavity	.013
" ulna at middle	.013
Diameters of head of radius { vertical	.0085
Diameters of head of radius { transverse	.015
Diameter of head of femur	.017
Diameters distal end of tibia { anteroposterior	.014
Diameters distal end of tibia { transverse	.017
Length of astragalus	.022
Greatest width of astragalus	.018
Diameters trochlea of astragalus { anteroposterior	.014
Diameters trochlea of astragalus { transverse	.011
Transverse diameter navicular facet do.	.018
" " cuboid " "	.002
Length of calcaneum	.042
" " tubercalcis	.025
Width calcaneum at sustentaculum	.0185
Diameters of cuboid facet { vertical	.0085
Diameters of cuboid facet { transverse	.013
Depth of calcaneum just behind cuboid facet	.013
Length of cuboid	.018
Distal diameters of cuboid { anteroposterior	.010
Distal diameters of cuboid { transverse	.010
Diameters of ectocuneïform { longitudinal in front	.008
Diameters of ectocuneïform { anteroposterior	.010
Diameters of ectocuneïform { transverse distally	.006

CONDYLARTHRA.

Among the specimens which represent this suborder, some display portions of the temporary dentition. I have already described this in Periptychus, but have had no light on that of the other genera.

A cranium and a separate set of jaws of *Haploconus corniculatus* display the last two temporary molars of the superior series. The third superior true molar is just protruding and the two temporary molars in question remain in place considerably worn. The last temporary molar is scarcely distinguishable in all its details from the permanent true molars. The penultimate deciduous premolar closely resembles in form and size the permanent first premolar, differing only in the presence of a small anterior basal cusplet. In a lower jaw of the *Anisonchus gillianus* the deciduous last inferior premolar is in place with the crown of its successor below it, and in front of the latter is the crown of the penultimate permanent molar. The penultimate deciduous molar is wanting. The last deciduous molar resembles in every respect the first true molar. We have now in this kind of dental succession a state of affairs similar to that which I have described in the creodont genus Triïsodon, and which is probably common to all Creodonta. The last deciduous molar in both jaws resembles exactly the true molars. Were this tooth not shed these animals would be like the Marsupialia in presenting the false appearance of four true molars.

I have shown that in Ectoconus the deciduous premolars iv and iii have the pattern of the permanent true molars (Tert. Vert., Pl. XXIX d, fig. 4). The corresponding inferior deciduous teeth are also like the true molars, the penultimate with the fifth cusp more anterior in position.

In the genus Protogonia I have observed that the last deciduous inferior premolar is rather more complex in its form than the first true molar. It possesses three distinct lobes arranged longitudinally, as in the Diplarthra, but the anterior lobe is not so well developed as in those animals. The specialization of this tooth has not progressed so far as it has in the Diplarthra, but a little more than in the Periptychidæ. This character may serve to distinguish the Phenacodontidæ from the Periptychidæ.

In Periptychus, as I have already shown, the last deciduous molar is more complex than the premolar which succeeds it, but is not quite so much so as a true molar. It has also a rudiment of the third lobe anteriorly, indicating a step beyond Haploconus in anteroposterior enlargement, while it is a step behind in transverse development. The three genera, considered together, display such a series of progressive modification of the last deciduous premolar, as to convince one of its possession of a

history of its own, and to confirm the Flowerian idea that the deciduous dentition is an addition to mammalian development, and not a survival of reptilian conditions. They also show that the proposition of the same author that the Marsupialia have four true molars is untenable, as I have previously claimed.

Fragments of skeletons of the smaller Periptychidæ are not rare in my collection. I have been unable so far to fix their species, and as they present no important differences from the corresponding parts of Periptychus, I do not now describe them.

The mandibular dentitions of the species of the smaller Periptychidæ are very much alike, and they are with difficulty distinguished one from another. I give the following table to facilitate their determination.

I. Anterior external cusp of true molars extended forwards, but not incurved.

a. Premolars elongate and compressed.

Molar series about .033 m..... *Haploconus xiphodon.*

aa. Premolars shorter, oval in longitudinal section.

Molars .025..... *H. angustus.*

" .032..... *H. lineatus.*

" .044..... *H. corniculatus.*

II. Anterior external cusp of true molars with anterior ridge directed inwards to a more or less developed fifth cusp.

a. Premolars robust, with wide section.

Premolars with oval section ; true molars .016..... *H. entoconus.*

Premolars with oval section ; true molars .009..... *H. cophater.*

Premolars nearly round in section ; molars .019 ..... *Hemithlæus kowalevskianus.*

aa. Premolars narrower, with strong anterior cusp.

True molars .018..... *Anisonchus sectorius.*

True molars .014..... *Hemithlæus apiculatus.*

True molars .012..... *Anisonchus gillianus.*

True molars .011..... *A. agapetillus.*

aaa. Premolars much compressed and elongate.

True molars .040..... *A. mandibularis.*

The mandibular dentition of *Anisonchus coniferus* is not sufficiently well known to be introduced into the table.

HAPLOCONUS Cope.

Amer. Naturalist, 1882, p. 417 ; Tertiary Vertebrata, 1885, p. 415.

The penultimate and last superior milk molars of this genus have been described above, together with the inferior milk molars in the genus Anisonchus. It results from these observations that the peculiar form of last and penultimate inferior premolars which I have observed in the *Haploconus xiphodon* are permanent teeth, as I

have already supposed (Tertiary Vertebrata), and that the inferior dentition represented in my Plate XXV e, fig. 6, as the milk dentition of that species, is not such, but is the permanent dentition of the *H. lineatus*. The premolars in question are much worn, so that the absence of the last true molar is probably due to accident rather than to non-protrusion. A second specimen of the *H. xiphodon* confirms its characters.

Additional specimens of the *Anisonchus cophater* show that it is referable to this genus. This, with the new *H. corniculatus*, increases the species of Haploconus to six.

HAPLOCONUS CORNICULATUS Cope, sp. nov.

Five more or less complete crania and a set of jaws represent this species. Its characters are to be seen in its peculiar superior molar teeth, and in its superior size.

The species presents the general characters of the *H. lineatus*, especially as to the form of its first premolar, which has the internal cusp an elevated concentric cingulum, and its enamel vertically striated with shallow grooves. The anterior cingulum of the true molars however terminates at its interior extremity in an acute erect cusp which is wanting in the *H. lineatus*, and the cusp of the posterior cingulum is isolated by a notch of the latter, which develops a second lower cusp immediately posterior to the first mentioned. This second posterior cusp is seen on the posterior molar of the *H. lineatus*, but not on any of the others. The dimensions of the *H. corniculatus* are constantly superior to those of the *H. lineatus*, as the following measurements will show. The lengths on the superior molar series to the canine tooth, in three specimens of each species, are as follows:

H. corniculatus	.045	.043	.040
H. lineatus	.034	.033	.035

The skull is elongate and is narrow in the cerebral region. The sagittal crest is low, as is also the inion. The orbit is small and lateral. The canines are directed vertically downwards.

Measurements of Skull.	*M.*
Total length	.125
Length from occipital condyle to last molar	.058
Width between last molars, inclusive	.037
" " canines, inclusive	.026

The inferior dentition is similar to that of the *H. lineatus*, but is more robust.

HAPLOCONUS COPHATER Cope. *Anisonchus cophater* Cope; Proc. Amer. Philos. Soc., 1883, p. 321.

This species, described from a fragment of a mandibular ramus, is now represented by a large part of a second ramus supporting five teeth, and an anterior part

of a cranium with both series of superior molar teeth, lacking the anterior two premolar crowns. The only reason for associating the last specimen with the two others, is the identity in proportions and dimensions between them, and as the species differ widely in these respects from the others of the genus, the association is justified by our knowledge as far as it goes.

The dental characters of the upper series are a diminutive of those of the *H. entoconus*. The internal cusp of the first premolar is a well-developed cone. The fourth or posterior cingular cusp of the true molars is conic, and is almost on the inner side of the third. The anterior cingulum is distinct and reaches the fourth tubercle. The external cingulum of the true molars is very strong, but is reduced to a trace on the first and second premolars. The second external cusp of the last true molar is very rudimental, so that that tooth is narrower than the others, and than in the *H. lineatus*. There is a ledge at the anterior base of the first premolar.

The infraorbital foramen issues above the posterior border of the anterior root of the second premolar. The zygomatic ridge of the maxillary originates above the middle of the first true molar. The nasal bones are elongate.

In the mandibular dentition the first premolar is larger than any of the true molars, and has a well-developed heel. Its section is nearly a half circle in outline, the external face being convex. The true molars have a cingulum on the anterior half of the crown; the premolars none at all.

Measurements.	*M.*
Length of superior dental series (p. m. iv, estimated)	.024
" " true molars	.008
Diameters p. m. i, anteroposterior	.003
Diameters p. m. i, transverse	.005
Diameters m. ii, anteroposterior	.0025
Diameters m. ii, transverse	.006
Width between p. m. ii	.010
" " m. iii	.009
Length posterior four inferior molars	.013
Diameters p. m. i, anteroposterior	.0042
Diameters p. m. i, transverse	.0025
Diameters m. i, anteroposterior	.0034
Diameters m. i, transverse	.0022
Depth of ramus at m. i	.011

This, with the *Anisonchus agapetillus*, is the smallest species of the Condylarthra. It will not be certain until the superior dentition of the latter is discovered, whether it belongs to this genus or the one in which I have provisionally placed it.

ANISONCHUS Cope.

Proc. Amer. Phil. Soc., 1881, p. 488; Tertiary Vertebrata, 1885, p. 408.

ANISONCHUS MANDIBULARIS Cope; Amer. Naturalist, 1881, p. 831. *Mioclænus mandibularis* Cope; Tertiary Vertebrata, 1885, p. 339.

The discovery of a second specimen of this species, which includes nearly all of the dentition of both jaws, proves that the position I originally assigned it is the correct one. The second superior premolar is like the first in having an internal cusp, whose base is, like that of the *A. sectorius*, concentric with the principal cusp of the crown.

The great peculiarity of the species, which is displayed by all the specimens, is the relatively large size of the second inferior premolar. It exceeds the first in anteroposterior extent, which is in turn longer than any of the true molars. The third premolar is also shorter than the second. The fourth premolar and canine are not preserved. The fifth cusp is well developed on the first and second true molars, but is of reduced proportions on the third. The heel supports the two lateral and smaller median cusps usual in this group. On the third molar the laterals are compressed and the median has a posterior position.

In the superior true molars the second exterior cusp of the third is well developed. The fourth cusp is situated well inwards, further than in *A. sectorius*, but not so far as in *A. coniferus*. There is a short anterior cingulum, which disappears before reaching the internal angle of the crown. External cingulum distinct. The second premolar is as large as the first, and both have a small anterior basal tubercle. Enamel surface smooth. Third premolar of reduced diameters.

Measurements.		*M.*
Length of six superior molars		.036
" " true molar series		.016
Diameters p. m. ii	anteroposterior	.0065
	transverse	.007
Diameters m. ii	anteroposterior	.006
	transverse	.0075
Length of posterior five inferior molars		.029
" " inferior true molars		.016
Diameters p. m. ii	anteroposterior	.008
	transverse	.0035
Length of p. m. i		.005
Diameters m. i	anteroposterior	.005
	transverse	.0042

HEMITHLÆUS Cope.

Amer. Naturalist, 1882, p. 832.

But two species of this genus are known to me, one of which has not been described. This is the *H. apiculatus*, and it shows such strong tendencies to Anisonchus that it is possible that the two genera will have to be combined. Both species of Hemithlæus have an internal cusp on the second superior premolar, as in Anisonchus. The position of the *A. baldwini* remains uncertain.

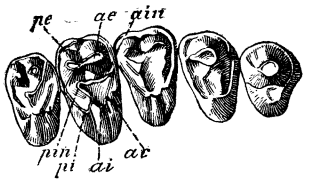


Fig. 11.

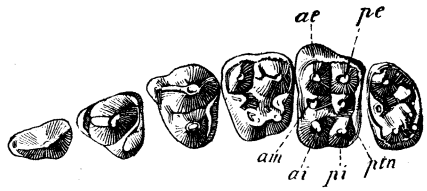


Fig. 12.

Fig. 11. *Hemithlæus kowalevskianus*, last five superior molars, $\frac{8}{5}$ natural size. Fig. 12. *Protogonia puercensis*, superior dentition, less fourth premolar, $\frac{6}{5}$ natural size.

HEMITHLÆUS APICULATUS Cope. *Anisonchus apiculatus* Cope; Tertiary Vertebrata, 1885, Pl. XXV e, fig. 7.

The mandibles of this species have been in my possession for a considerable time, and I have regarded them as indicating a small variety of the *Anisonchus sectorius*. But the discovery of the superior dental series shows that the species is quite distinct, and belongs between that animal and the *Hemithlæus kowalevskianus* in its characters.

As in the type of Hemithlæus there are an anterior and a posterior cingula of the superior molars. The posterior cingulum is produced a little further inwards than the anterior, but on the first true molar its border does not project further inwards than the internal angle of the crown. In the second molar it projects a little further, while in the third it projects so distinctly beyond the third cusp as to resemble the condition seen in Anisonchus. The anterior edge of the cingulum does not form a cusp, however, in either tooth, and for this reason I retain the species in the genus Hemithlæus. External cingulum distinct. The internal cusps of the first and second premolars are intermediate in form between the concentric type of *A. sectorius* and the conic form of *A. coniferus*. The transverse diameter of the first premolar is a little greater than that of a true molar, while the crown of the third premolar is subtriangular in section. The infraorbital foramen issues above the second premolar.

In the inferior true molars the fifth cusp is present, and is connected by ridge with

the external anterior. The opposite cusps of the heel are well developed, but the posterior median is quite rudimental. The first and second premolars are larger than the molars, but not disproportionately so, and they have a characteristic form. The crown is wide at the principal cusp, but the heel is small and is at the inner side of its posterior face. There is an anterior cusp which is a little to the inner side of the middle line of the principal cusp, and which is distinct at a point much above the base of the crown, being marked off from the main cusp below by a shallow groove. A line passing through the long axis of the crown is an open sigmoid. The last true molar rises on the base of the coronoid process. Both the external side of the ramus and its inferior margin are gently convex. The anterior border of the masseteric fossa is distinct, but there is no inferior border.

Measurements.	*M.*
Length of superior molars except p. m. iv	.025
Length of true molars	.0112
Diameters of p. m. iv { anteroposterior	.004
Diameters of p. m. iv { transverse	.0065
Diameters of m. ii { anteroposterior	.0035
Diameters of m. ii { transverse	.007
Length inferior molars less p. m. iv and iii	.023
Length true molars	.0125
Diameters of p. m. i { anteroposterior	.0048
Diameters of p. m. i { transverse	.0036
Diameters of m. ii { anteroposterior	.0045
Diameters of m. ii { transverse	.0038
Depth of ramus at m. i	.010
" " " " m. ii (posteriorly)	.012

Jaws of eight individuals of this species have come into my possession.

HEMITHLÆUS KOWALEVSKIANUS Cope ; Amer. Naturalist, 1882, p. 832 ; Tertiary Vertebrata, 1885, p. 405.

A crushed cranium of this species shows some points previously unknown. The sagittal crest is low and divides into the temporal crests, which diverge widely and rapidly to the postorbital angles. These are distinct, but not produced. The orbits are small, and have a partially upward direction. The infraorbital foramen opens above the anterior border of the second premolar. The latter tooth has a well-developed internal cusp. The palate is wide, but as the skull has been crushed this width is probably exaggerated.

In the inferior dentition this species may be readily distinguished by the very robust first and second premolars which are shorter and wider than in any other.

PERIPTYCHUS Cope.

Amer. Naturalist, 1881, p. 337; Tertiary Vertebrata, 1885, p. 387.

PERIPTYCHUS COARCTATUS Cope; Tertiary Vertebrata, Pl. XXIX d, explanation, and figs. 7-8; Amer. Naturalist, 1884, p. 801, fig. 10.

This, with the *P. brabensis*, is characteristic of the lower beds of the Puerco, as the *P. rhabdodon* is of the upper beds. It is not so abundant as either of the others, only five individuals having come into my possession.

This species is of smaller size than the *P. rhabdodon* and the *P. carinidens*, and is especially distinguished from both, in that the cingulum of the inferior premolars is not continuous on the inner side of the crown, but is confined to the anterior and posterior bases, sometimes to the posterior base exclusively. The first and second premolars are larger than the true molars, and the latter diminish in size posteriorly. In the inferior molars the fifth cusp is present, and as in the premolars there are traces of external cingula. The grooved striation of the crowns is distinct. The characters which distinguish the species from the *P. brabensis* are the following. The transverse diameter of the superior premolars is relatively much greater than in the *P. rhabdodon* and *P. brabensis*, and the true molars have a transversely compressed form. There is a faint cingulum on the external base of the true molars and first premolar in both jaws, at which the grooves of the enamel terminate abruptly. This is wanting in the *P. brabensis*. The external faces of the superior premolars are directed obliquely forwards and inwards, a character not seen in the *P. brabensis*.

Measurements of Superior Molars.		*M.*
Diameters p. m. i	anteroposterior	.011
	transverse	.016
Diameters p. m. ii	anteroposterior	.011
	transverse	.016
Diameters m. ii	anteroposterior	.0095
	transverse	.013

PERIPTYCHUS BRABENSIS sp. nov.

Twenty individuals represent this species in my collections, nearly all of them consisting of jaws only. Of these four only present the dentition of both jaws; one exhibits nearly the entire dentition of both maxillary bones, and one the last temporary molar of the lower jaw.

This species is still smaller than the *P. coarctatus*, and differs from it in the same way, *i. e.*, in the non-continuation of the cingulum across the interior side of the inferior premolars. But it differs from the *P. coarctatus*, as already

pointed out, in the smaller transverse diameter of the premolars, especially of the superior series, and in the absence of cingula on the external side of the premolars in both jaws. The inferior true molars also possess but traces of the cingula. The internal cingulum of the superior premolars is extensive, continuing round to the front and nearly to the external base of the first premolar. In the inferior premolars there is a short posterior heel, and on the first, a short anterior cingulum, which is however not always present. The infraorbital foramen issues above the front of the first premolar.

Measurements. No. 1 type.		*M.*
Length of p. m. i, m. i, and m. ii, superior		.029
Diameters p. m. i	anteroposterior, superior	.011
	transverse, "	.013
Diameters p. m. ii, inferior	anteroposterior	.012
	transverse	.008
Superior Molars, No. 2.		
Length of molar series		.070
" " true molars		.029
Diameters m. i	anteroposterior	.010
	transverse	.011
Diameters m. ii	anteroposterior	.098
	transverse	.013
Inferior Molars, No. 3.		
Length of last five molars		.050
Diameters p. m. i	anteroposterior	.0115
	transverse	.0095
Diameters of m. ii	anteroposterior	.008
	transverse	.008
Diameters of m. iii	anteroposterior	.0088
	transverse	.007

From the Lower Puerco only. D. Baldwin.

ECTOCONUS Cope.

Amer. Naturalist, 1884, p. 795; Tertiary Vertebrata, 1885, Pl. XXXV.

But one species, the *E. ditrigonus* Cope, is known. Excepting the brief notes contained in the above-mentioned publications the general characters of both genus and species remain undescribed.

In the superior dentition the first, second and third premolars possess one external and one internal cusps. In the inferior series the first and second have an internal cusp and a heel. The coracoid process is a robust recurved tuberosity. The astragalus is slightly convex anteroposteriorly, and slightly concave transversely. The

trochlea is not oblique to the axes of the bone. The head presents convex faces anteriorly interiorly. The anterior face is convex in every direction, and is continued to the external side. The internal face is not separated from the anterior along the superior border, but is separated below and distally by a strong notch. This interior facet indicates a large tibiale or "internal navicular," a bone well known in Rodentia, and in Bathmodon among the Coryphodontidæ. This facet is larger than in Periptychus, and in the latter genus it is not cut off by a groove as in Ectoconus. The calcaneum has a very long tuber. The astragaline facets are in a general horizontal plane, the internal (sustentaculum) small and a little concave; the external large, wide, and a little convex. No distinct fibular facet. The cuboid facet is large, and nearly anterior in presentation. The cuboid has the usual tuberosity, and also a large distal facet.

The foot was evidently entirely plantigrade and pentadactyle in this genus.

In its dentition Ectoconus presents the most complex known form of the tritubercular type.

ECTOGONUS DITRIGONUS Cope; Amer. Naturalist, 1884, p. 796, fig. 4. *Periptychus ditrigonus* Cope; Tertiary Vertebrata, p. 404, Pl. XXIII g, fig. 12. *Conoryctes ditrigonus* Cope; Tertiary Vertebrata, 1885, Pl. XXIX d, explanation, and figs. 2–6.

Thirty-two individuals of this species have been sent me, all from the Lower Puerco beds. The most important of these include the teeth and all the dentigerous bones, excepting the premaxillaries, with fragments of humerus, scapula and tibia with calcaneum, astragalus and cuboid elements entire. Of another, the proximal parts of the astragalus and calcaneum are preserved with the heads of the first, a median, and the fifth metatarsals.

The dentition has been described so far as the molars and superior incisors are concerned. The first and second true molars usually possess eight cusps, but occasionally there are nine, that is two external cingular cusps. The heels of the first and second inferior premolars are tubercular, and the external cingulum of the inferior true molars is well marked. The enamel is nearly smooth.

The external (fibula) side of the astragalus is a vertical facet. The internal face is nearly vertical. Beyond it a large depressed tuberosity projects a short distance inwards but not posteriorly. It bounds the sustentacular facet of the astragalus behind. This postsustentacular tuberosity is truncated inwards and downwards posteriorly. The sustentacular process of the calcaneum projects outwards and forwards in a subcircular rim beyond the smaller subround facet. The external facet forms about one-fifth of a circular band, the concavity being next the middle of the proxi-

mal end of the bone. Between it and the sustentacular facet is a ligamentous fossa In front of it the superior surface descends into a deep transverse notch which receives a descending angular process of the astragalus which is broken from my specimens. In other words the superior border of the cuboid facet rises upwards abruptly in front of this depression. This facet is quite large and narrows to an apex inwards, where it terminates at a small vertical tuberosity. Inferior to this apex is a subtriangular fossa, which is bounded externally by another tuberosity. A large longitudinal tuberosity supports the external border of the cuboid facet on the inferior side.

The skull fragments show that this species differed from all of the known Periptychidæ in having a very high and robust sagittal crest.

Three vertebræ of the specimen described are preserved, the axis, a lumbar and two caudals; all without arches. The axis is about as long as the lumbar, omitting the odontoid process. The latter is rather short and is depressed, the section being a transverse oval. Its articular surface is continuous with the atlantal facets. Body with a median inferior keel. The lumbar is short, but exceeds the axis in transverse diameter. The articular faces are subplane, while the sides of the centrum are concave, and not keeled at any point. Two strong foramina perforate the floor of the neural canal. The bodies of the caudals are depressed and a little longer than wide. One of them has a median keel-angle below. Other specimens show more distal caudals of elongate form, showing that this species had a long tail like the *Phenacodus primævus.*

Measurements of sp. No. 1.		*M.*
Length of superior true molars with p. m. i and ii		.044
Diameters of p. m. iv	anteroposterior	.007
	transverse	.011
Diameters m. i	anteroposterior	.010
	transverse	.013
Diameters m. ii	anteroposterior	.010
	transverse	.013
Diameters m. iii	anteroposterior	.009
	transverse	.012
Length inferior dental series including canine		.073
Diameters base of canine	anteroposterior	.008
	transverse	.0085
Length of true molars		.034
Diameters p.m. i	anteroposterior	.008
	transverse	.0085
Diameters m. ii	anteroposterior	.0105
	transverse	.010
Diameters m. iii	anteroposterior	.012
	transverse	.009

Measurements of sp. No. 1.	M.
Depth of ramus at p. m. iii	.021
" " " m. i	.025
Diameter axis: anteroposterior, total	.030
Diameter axis: transverse, greatest	.032
Length of odontoid process to atlantal facet	.009
Diameters lumbar centrum: anteroposterior	.020
Diameters lumbar centrum: articular face: transverse	.030
Diameters lumbar centrum: articular face: vertical	.021
Diameters proximal caudal centrum: anteroposterior	.021
Diameters proximal caudal centrum: articular: transverse	.016
Diameters proximal caudal centrum: articular: vertical	.015
Widths of scapula proximally: anteroposterior, total	.041
Widths of scapula proximally: " glenoid cavity	.029
Widths of scapula proximally: " neck	.033
Widths of scapula proximally: transverse, glenoid cavity	.019
Diameters distal end of tibia: anteroposterior*	.022
Diameters distal end of tibia: transverse	.025
Greatest length of astragalus	.035
" width " "	.026
Diameters of trochlea: anteroposterior	.021
Diameters of trochlea: transverse	.018
Length of calcaneum	.058
Width proximally (transversely measured)	.038
Transverse extent of sustentaculum	.014
Transverse diameter of cuboid facet	.018
Length of cuboid	.019
Transverse diameter of distal facet do.	.019
Vertical " " " "	.011

Specimen No. 2.	
Diameters peduncle of ilium: anteroposterior	.025
Diameters peduncle of ilium: transverse	.022
Width of internal side of peduncle of ilium	.020
Diameters of acetabulum: anteroposterior	.028
Diameters of acetabulum: vertical	.028
Greatest diameter of peduncle of pubis	.011
Diameters of ischium at spine: anteroposterior	.027
Diameters of ischium at spine: transverse	.009
Estimated length of femur	.140
Width do. at condyles	.045
Anteroposterior diameter do. at rotular crests	.042

The pelvis has large obturator foramina. The ilium is rather short and robust, and it has a wide anterior face to the crest, but this is not so wide as the interior face, except at the peduncle, where it is wider. The anterior inferior spine is a vertical oval tuberosity a centimeter above the acetabulum. The latter has a wide ligament-

* A small posterior tuberosity estimated for.

ous fossa at the fundus, and the usual ischiadic notch and groove. The pubis is slender. The ischium is flat, and the tuberosity is a convexity of the posterior edge which terminates in a little angular contraction, forming a "spine."

The fossa ligamenti teris of the femur is a fissure which runs out to the margin of the head. The trochanters are large; the third moderately prominent, and partly opposite to the lesser trochanter. The rotular groove is wide and elevated, and its borders are equal. The external condyle is narrower than the internal. On the whole the femur is a good deal like that of the *Periptychus rhabdodon.*

PROTOGONIA Cope.

Proc. Amer. Phil. Soc., 1881, p. 492; Tertiary Vertebrata, 1885, p. 424. *Phenacodus* pt. Cope; loc. cit., 1881, p. 492; 1885, p. 488.

This genus was originally distinguished from Phenacodus by the presence of but one external tubercle on the first superior premolar, since there are two in Phenacodus. Additional specimens show that the second external tubercle of the *P. puercensis* is normally rudimental, so that that species may be properly referred to Protogonia. It is further distinguished from Phenacodus by the presence of but one external cusp on the second superior premolar, in which it agrees again with the species referred to Protogonia. The latter genus thus defined embraces five species which differ as follows:

I. Fifth cusp present on inferior true molars.

Last four inferior molars, .025; internal cusp on inferior p. m. i, rudimental.....*P. zuniensis.*

Last four inferior molars, .030; internal cusp of inferior p. m. i, large.....*P. plicifera.*

II. Fifth cusp wanting from inferior molars, except sometimes m. i.

First superior premolar with rudimental second external cusp; inferior true molars, .026; last robust premolars with no, or tubercular heels.....*P. puercensis.*

Inferior true molars, .026; last small; premolars with wide, flat, smooth heels.....*P. calceolata.*

As may be seen from the catalogue of species, the material representing this genus is quite abundant. This is true only of jaws and teeth, for identifiable parts of skeletons are yet very rare. A very much damaged cranium of the *P. puercensis* displays nearly all the dentition, the incisors and the fourth premolar being absent. The first and second premolars only have internal cusps. In the superior canines the vertical direction is the same as is seen in Haploconus sp.

The fifth cusp is wanting from the last inferior true molar in the *P. plicifera,* and is in a few specimens absent from the second also. Specific difference cannot be predicated on the presence or absence of this cusp, although in more specialized types, its variations are of generic importance. The premolars of the lower series are spaced in the *P. plicifera,* while they are in close succession in the *P. puercensis.*

AMBLYPODA.

PANTOLAMBDA Cope.

Amer. Naturalist, 1882, p. 418; Tertiary Vertebrata, 1885, p. 601.

Additional material belonging to the two known species of this genus, throw light on points of structure hitherto unknown.

As regards the dentition, the superior premolars are identical with those of Coryphodon.

In the anterior foot the cuneïform has the general character of that of Coryphodon. The pisiform facet is wider, thus approaching the unguiculate types of the same epoch.

In the posterior foot the cuboid of the *P. cavirictus* differs from that of any of the Coryphodontidæ which I have seen in the greater mutual obliquity of the two proximal facets. That for the astragalus is a wide concave fossa; that for the calcaneum is a hook-shaped band, the convexity proximad, and the longer arm, or stem, of the hook anterior, and the shorter posterior to a ligamentous fossa. The anterior band-like facet turns transversely distally. The position of the cuboid is oblique in the foot, giving the digits which arise from it a divergent direction externally. The astragalus of this species closely resembles that of *P. bathmodon*. The ectocuneïform is much like that of Coryphodon, but is not so depressed, the anterior face being square. The mesocuneïform has only two-thirds the longitudinal depth in front. The entocuneïform is narrower transversely than in Coryphodon, and approaches the form of some of the unguiculates. It indicates a smaller internal digit than in Coryphodon. The above-described bones all belong to one individual.

EXPLANATION OF PLATES.

PLATE IV.

Hemiganus otariidens Cope, natural size.

Fig. 1. Part of maxillary bone displaying canine and two premolar teeth, with ? lachrymal foramen at *a*; and with part of premaxillary bone.

Fig. 2. Left ramus of mandible from left side. The ? canine was found separate, and is drawn in; *a*, same from above, canine omitted.

Fig. 3. Parts of pariëtal and frontal bones from above; *a*, temporal ridge.

Fig. 4. Right frontal and part of pariëtal bone, the sutural surface showing olfactory fossæ on inferior face.

Fig. 5. Left inferior ? canine tooth represented in fig. 2, from front; *a*, from behind.

Fig. 6. Inferior premolar tooth free from alveolus, from front; *a*, from inner side; *b*, from above.

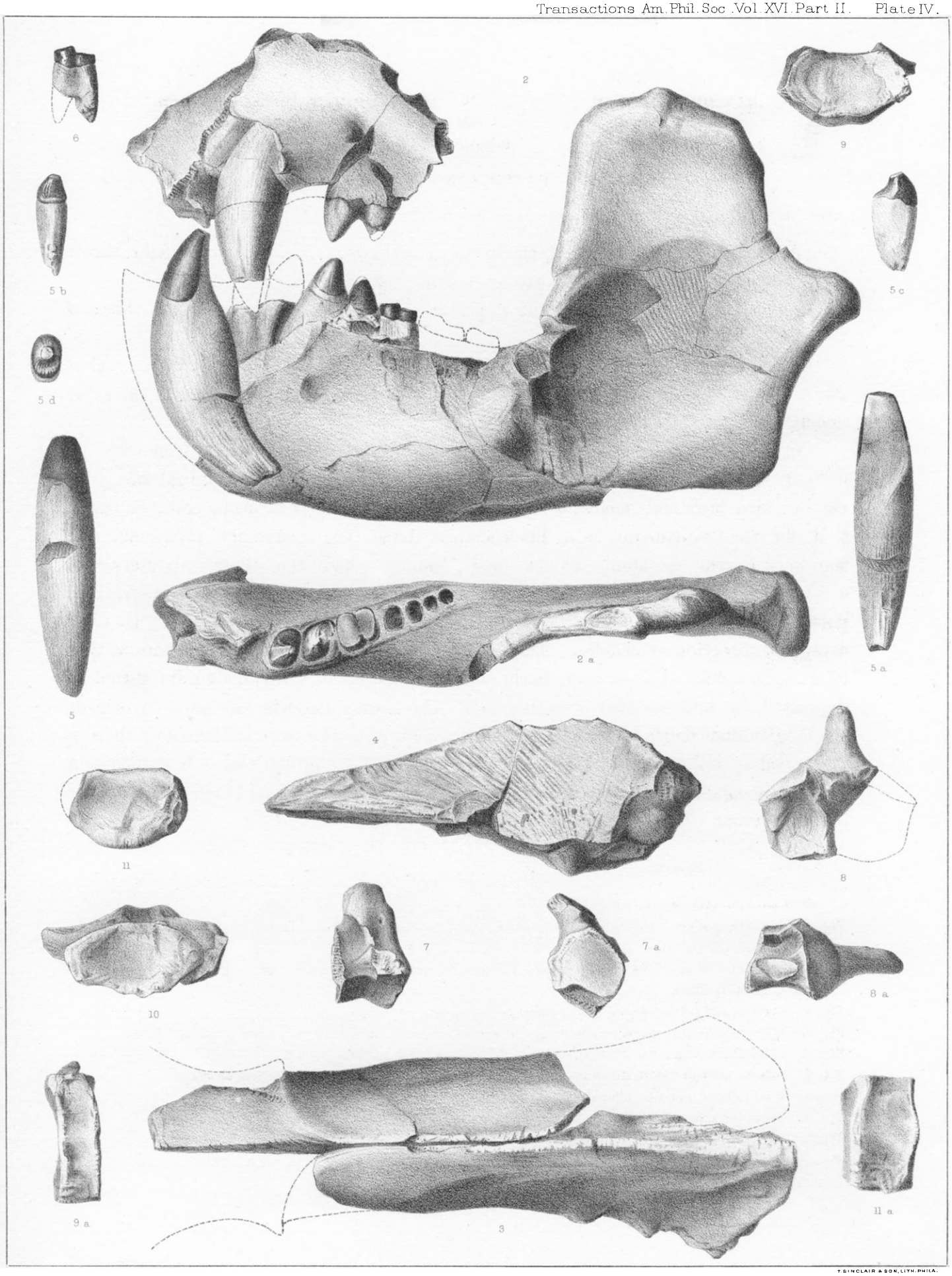
Fig. 7. First inferior molar of right side, external view.

Fig. 8. Atlas, left half, from left side; *a*, from behind.

Fig. 9. Axis from above; *a*, from right side.

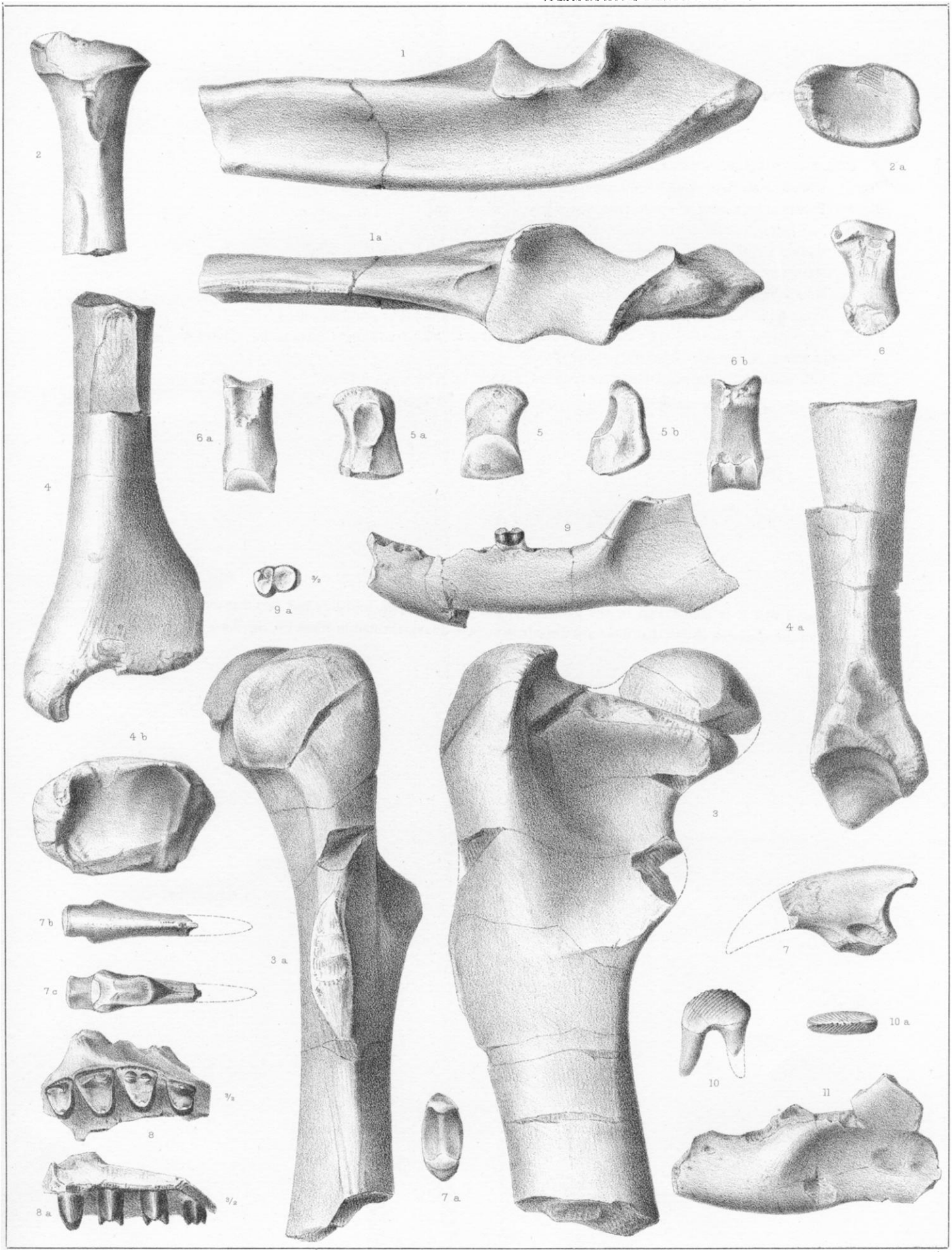
Fig. 10. Cervical vertebra without epiphyses; *a*, from below.

Figs. 11–12. Cervical vertebræ; *a*, from below.



T. SINCLAIR & SON, LITH. PHILA.

HEMIGANUS OTARIIDENS COPE ½



1-7. HEMIGANUS OTARIIDENS ½. 8-9. ONYCHODECTES TISONENSIS.

10-11. NEOPLAGIAULAX MOLESTUS ½.

ADDENDUM.

On page 311 it is stated that in the genus Hemiganus "there are probably but two true molars." Further cleaning of the specimen shows that there are three true molars, as represented in Plate IV, fig. 2 a.

PLATE V.

Figs. 1–6. *Hemiganus otariidens*, parts of specimen figured on preceding plate, natural size.

Fig. 1. Ulna of right side, from within ; *a*, from above.

Fig. 2. Proximal extremity of radius from below ; *a*, proximal view.

Fig. 3. Left femur, proximal half, from behind ; *a*, external view.

Fig. 4. Distal half of right tibia, from front ; *a*, from external side ; *b*, distal extremity.

Fig. 5. Metacarpus of pollex, externoanterior view ; *a*, internal view ; *b*, edge view.

Fig. 6. Metapodial, from side ; *a*, from front ; *b*, from behind.

Fig. 7. Ungual phalange, side view ; *a*, proximal extremity ; *b*, from above ; *c*, from below.

Fig. 8. *Onychodectes tisonensis* Cope ; maxillary bone of right side, with four molars, from below, $\frac{3}{2}$ natural size ; typical specimen ; *a*, the same from the palatal side.

Fig. 9. Left mandibular ramus of the same species, natural size, broken, external side ; *a*, crown of second true molar seen from above, $\frac{3}{2}$ natural size.

Fig. 10. *Neoplagiaulax molestus* Cope, fourth inferior premolar, external view, natural size ; *a*, the same from above.

Fig. 11. *Neoplagiaulax molestus*, left mandibular ramus, with roots of fourth premolar only, external view ; natural size.